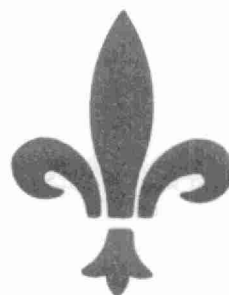
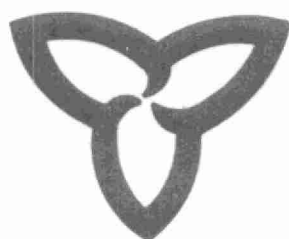


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water quality and its control in the ottawa river 1971

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OTTAWA RIVER BASIN

WATER QUALITY AND ITS CONTROL
in the

OTTAWA RIVER

PREPARED FOR THE PROVINCES OF
ONTARIO AND QUEBEC
BY

ONTARIO
WATER RESOURCES
COMMISSION

QUEBEC
WATER
BOARD

1971

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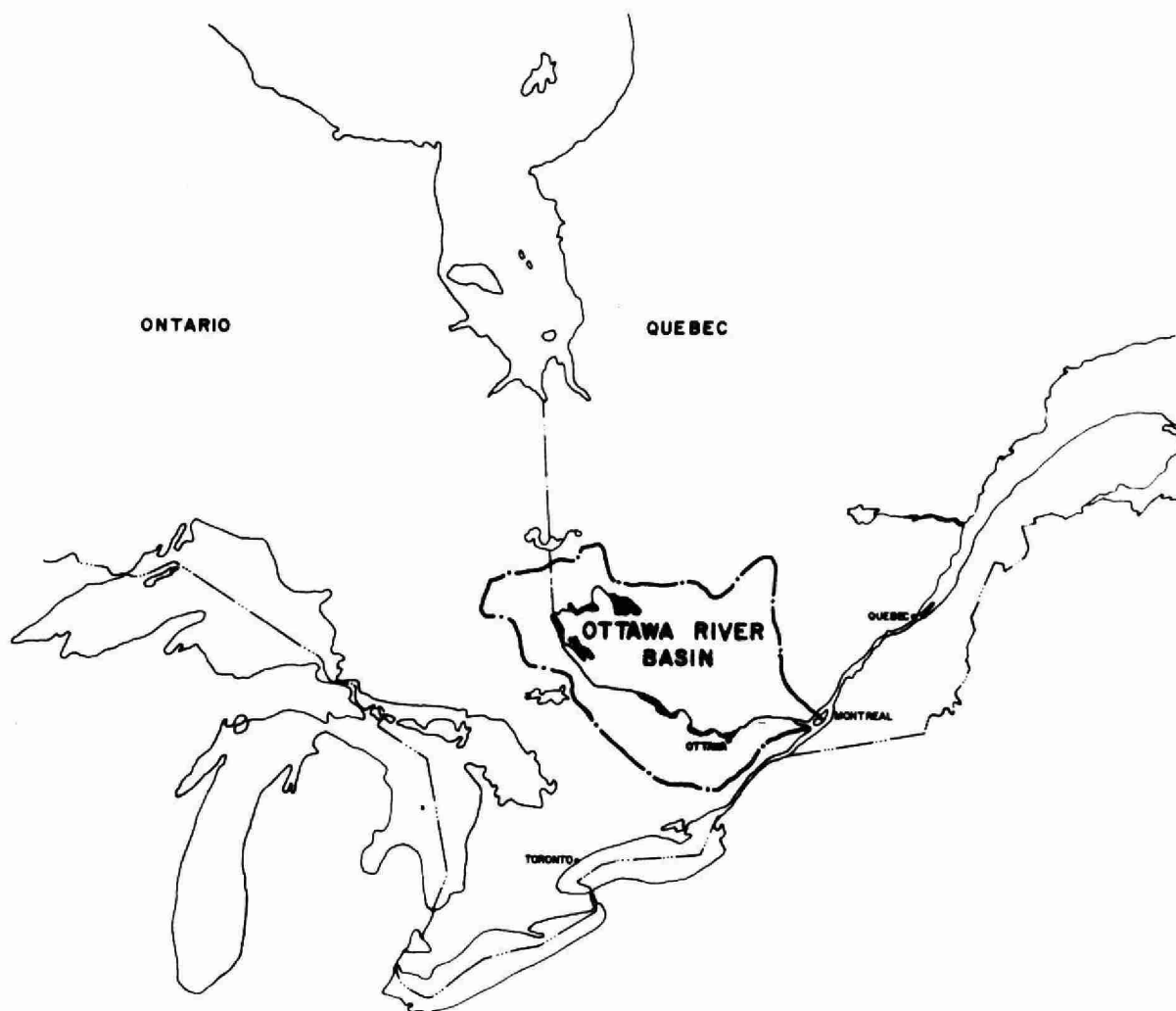
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INTRODUCTION

This report presents the findings of the joint study undertaken recently by Ontario and Quebec of the pollution of the Ottawa River. It is an investigation of the effects on water quality of the variety of uses of water in the basin and the controls required for restoration and maintenance of the quality of the river for the future. The information upon which the report is based was compiled by the Ontario Water Resources Commission and the Quebec Water Board over a three year period commencing in 1967.

The Ottawa River is the largest all-Canadian river in the eastern part of the country. It forms the interprovincial boundary between Ontario and Quebec for a distance of 383 miles from the head of Lake Timiskaming to the Carillon Generating Station at Pointe Fortune. A limited number of industrial establishments, based primarily upon forest resources and mining, are located in the northern portion of the basin. Electric power authorities of the two provinces have developed flow regulation measures to maximize the hydro-electric generating capacity of the river. The river is used extensively for recreation, water supply, log driving and waste disposal; the latter two uses frequently interfering with other desirable uses.

Water quality impairment in the river is evident downstream from the Town of Temiscaming to Deux Rivieres, a distance of 60 miles, and from the cities of Ottawa and Hull to the Lake of Two Mountains, a distance of 80 miles.

The pollution of the Ottawa River has been the subject of several previous reports. The most significant of these reports include those prepared by Dr. Lucien Piche (1954) for the Quebec Anti-Pollution League, the Ontario Department of Health (1956) and the Quebec Water Board (1965). The conclusions of all three reports were that the river was seriously polluted downstream from urban and industrial developments, especially in the Temiscaming, Ottawa-Hull and Hawkesbury areas. Appendix A contains a summary of the findings of the previous reports.

In 1967, Quebec and Ontario realized that independent studies could not capture the magnitude of the problems on both sides of the Ottawa River Basin. In order to resolve the concerns of both provinces, it was decided that joint action would have to be undertaken. Subsequently, on August 25, 1967, the Premiers of the two provinces announced that Ontario and Quebec would conduct a joint investigation of the pollution of the river. The study, commissioned by the Premiers, is the subject of this report by the Ontario Water Resources Commission

and the Quebec Water Board. It is expected to set a precedent for future co-operation in planning for the development and control of the water resources of the Ottawa River Basin.

The Ontario Water Resources Commission and the Quebec Water Board were requested to investigate water pollution in the Ottawa River, using the following guidelines for the conduct of the study.

- a) to ascertain the sources and quantities of waste discharges.
- b) to determine the effects of the waste discharges on the river.
- c) to evaluate existing and potential use patterns in order to define an overall water quality management plan for the basin.
- d) to establish water quality standards for the river taking into consideration present and future water requirements.
- e) to determine effluent requirements for individual dischargers.
- f) to estimate the cost of remedial works.

This report, based upon the above guidelines, gives recognition to the need for:

significantly reducing the waste loads presently being discharged to the Ottawa River by municipalities and industries.

on an interim basis, immediately establishing a plan to provide ongoing protection for the river by temporarily curtailing industrial operations when water quality is likely to fall below minimum acceptable levels.

developing integrated contingency measures for the control of spills of oil and hazardous substances.

A dynamic water quality management program will be necessary to provide for the planning and implementation of new and ongoing measures required to maintain satisfactory water quality conditions as populations grow and move into urban regions with their changing and increasing needs for water.

CHAPTER 1

SUMMARY AND RECOMMENDATIONS

1.1 SUMMARY

The Ottawa River is used for many purposes, some of which conflict with others. In early years, waste disposal, log-driving and hydro-electric power production were accepted without question as to their social and environmental consequences. In recent years public attention has been focused upon improving water supplies and increasing recreation potential while at the same time restoring a healthy balance of fisheries and wildlife consistent with sound ecological principles.

Major industries are generally found along the river while agriculture, recreation and forestry are dispersed throughout the basin. An urban population growth of 700,000 persons to a level of 1,850,000 is forecast over the thirty year period from 1961 to 1991, while a relatively stable rural population is indicated. The greatest growth in the basin is expected in the National Capital Region with other areas including Pembroke, Hawkesbury and the many small centres near the international airport at Sainte-Scholastique anticipating significant rates of growth.

This investigation has clearly defined areas of gross degradation of water quality in the upper portion of the river downstream from the Town of Temiscaming and in the lower portion of the river downstream from the cities of Ottawa and Hull. The overall quality of Lake Timiskaming was excellent. In the section of the river downstream from the Des Joachims Dam to the cities of Ottawa and Hull, recovery from observed effects of pollution was complete. The water quality was generally satisfactory in this stretch of the river with the exception of several significant but locally confined areas of impairment.

The greatest damage to water quality results from the discharge of substantial volumes of untreated pulp and paper mill wastes including large quantities of suspended solids (bark, wood chips and fibre), soluble organic compounds, colour and odour causing materials, toxic components and in two instances the deleterious effect of previously discharged organic mercurial compounds persists.

The highest concentrations of suspended solids and related sludge deposition occur downstream from the Kipawa mill of the Canadian International Paper Company at Temiscaming, the Hull mill of the E. B. Eddy Company, and the Gatineau mill of the

Canadian International Paper Company. Lesser effects are produced by the Masson mill of the James MacLaren Company (settling occurring in the Du Lievre River and Clement Bay), the Thurso mill of the Thurso Pulp and Paper Company, the Hawkesbury mill of the Canadian International Paper Company, and the Pontiac mill of the Consolidated Bathurst Company (located at Portage-du-Fort).

Soluble organic compounds discharged in pulp and paper mill effluents account for approximately 90 per cent of the total oxygen demand load on the river. These inputs, plus the additional oxygen demand created by benthic deposits and loadings from sanitary and other industrial waste sources, have been shown to deplete the dissolved oxygen content of the river downstream from the cities of Ottawa and Hull and downstream from the Town of Temiscaming to levels unsuitable for the maintenance of warm water fish species. Soluble organic compounds further impair water quality by creating aesthetically undesirable conditions of colour and odour immediately downstream from the mill outfalls. Generally excessive threshold odour values occur immediately below all mill discharges in the lower river below the Chaudiere Dam. Wood sugars and other organic compounds promote slime growths below all mill discharges to the river. These growths impair the aesthetic qualities of the river; adversely affect hatching success and survival rates of fish eggs and fry; and in conjunction with wood fibres, clog fish nets, water intake screens and industrial cooling systems. Increased maintenance costs have been reported at the Otto Holden and Chenaux hydro-electric generating stations. These increased costs have been related to the slime growths in cooling coils. Waste discharges from the Kipawa mill of the Canadian International Paper Company and the Pontiac mill of the Consolidated Bathurst Company contribute to these conditions.

The only known inputs of mercury from industrial sources were from the former use of mercurial compounds as slimicide agents by the E. B. Eddy Company (Hull) and the Canadian International Paper Company (Gatineau). Discharge of these materials has resulted in significant contamination of several fish species in the lower river which, in 1970, led to the closing of commercial fisheries downstream from the Chaudiere Dam. In addition, sport fishermen have been advised to "fish for fun" and limit the consumption of fish taken from this section of the river. While levels of mercury in the river sediments were highest downstream from these two companies, levels approaching 1.0 mg/kg were common in sediments throughout the lower river. It is likely that mercury in excess of acceptable levels will persist in fish flesh for many years.

The addition of inorganic nutrients, e.g. nitrogen and phosphorus, from municipalities and other sources results in concentrations in the river significantly greater than the normal background levels. This nutrient enrichment has led to an increase in the biological productivity of the river. The levels of nutrients in the natural lakes of the upper river are sufficient to sustain high productivity of algae and rooted aquatic plants without any further additions of nutrients from man-made sources. Increases in the amounts of total nitrogen and total phosphorus in the lower river can be attributed primarily to the major waste discharges from the cities of Ottawa and Hull and certain industries. Other municipal, industrial and tributary sources of nutrients contribute to both local problems and the increase in the supply of nutrients as the river advances downstream. Primary productivity levels which appear to be extremely high in the Lake of Two Mountains are undoubtedly related to the accumulation of nutrients from upstream inputs. Winter oxygen depletion in shallow, productive bays of the lake is probably caused by excessive organic decomposition in the absence of reaeration. Aquatic plant production is presently considered to be of nuisance proportions relative to recreational activities.

Raw and inadequately treated waste discharges cause bacterial contamination which interferes with the use of the river for bathing and swimming. This occurs locally in many areas upstream from the Chaudiere Dam and extensively along both shorelines downstream from the cities of Ottawa and Hull. In particular, high levels of contamination occur downstream from Hull as a result of the discharge of large volumes of untreated municipal and slaughterhouse wastes from the city and from Canada Packers Limited; similarly bacterial contamination occurs downstream from the discharge of the primary sewage treatment plant of the City of Ottawa.

Oil slicks have been observed at several locations along the Ottawa River. In recent years, the most serious spills have occurred in the Ottawa-Hull vicinity.

In order to restore water quality and maintain it at a level acceptable for the greatest number of uses, a reasoned approach to the use of the river will be required by the water users in the two provinces. To accomplish the apparently inconsistent objectives of desired community and economic growth with restoration and preservation of the quality of the Ottawa River, it may become necessary to limit the locations available for industrial development. Relocation of existing industries may be desirable where the necessary measures required to control pollution are not feasible for certain industrial activities.

Standards of water quality which reflect the objectives of a balanced ecology compatible with the foreseeable water uses are presented. The following key considerations are basic to the implementation of the standards.

1. The responsibility for demonstrating that a waste effluent is harmless to water uses in the concentrations to be found in the receiving water rests with those producing the discharge.
2. All wastes prior to discharge to the river must receive the best practicable treatment or control consistent with the water quality standards.
3. Waste treatment requirements have been specified for: the removal of suspended solids; the disinfection of effluents for the control of pathogenic organisms; the reduction of BOD levels; the control of nutrients; the elimination or control of toxic materials, tainting substances, taste and odour causing materials, oils and petrochemicals, dissolved materials, heated effluents, materials affecting pH, alkalinity, colour and turbidity, and radioactive materials.

The immediate objective of this study is to rectify past and present abuses of the Ottawa River in order to achieve and maintain water quality conditions compatible with desirable river uses.

It is recognized that water quality considerations must become an integral part of future overall planning of land and water use. It may ultimately become necessary to encourage some uses of the river over others as a result of economic or social pressures. In doing so, it will be necessary to select among various alternatives for achieving these objectives.

However, at the present stage of development in the Ottawa River Basin, recognizing the lack of adequate water pollution control in the past, it is technically feasible and economically justifiable to satisfy reasonable standards of water quality without extensive consideration of numerous alternatives. This report presents a proposal that will facilitate the maintenance of water quality at such a level as to support the numerous existing and foreseeable uses of the Ottawa River. The waste treatment requirements outlined have been utilized to estimate costs of the necessary remedial measures. Capital costs for municipal and industrial sewage treatment and sewerage facilities, exclusive of land and financing costs were estimated to be \$35-45 million in Ontario and \$55-65 million in Quebec.

The implementation of the measures in this report is the first step necessary in the development of a continuing program to effectively manage the water resources of the basin.

1.2 RECOMMENDATIONS

The Ontario Water Resources Commission and the Quebec Water Board recommend:

1. that Ontario and Quebec place restrictions on individual waste dischargers to achieve the water quality standards for the Ottawa River as set forth in this report.
2. that by December 31, 1971, all dischargers submit proposals to the Ontario Water Resources Commission and the Quebec Water Board defining the remedial measures necessary to achieve compliance with the water quality standards in accordance with the following:

- a) immediate priority be given by the pulp and paper industry to the installation of treatment facilities to accomplish the removal of settleable suspended solids no later than December 31, 1973. These programs should further provide for the elimination or reduction of all pollutants in waste effluents as soon as possible and in no case later than December 31, 1977.

Toxic substances, nutrients and organic components of waste effluents are of particular importance.

- b) other industries should provide adequate waste treatment facilities for the elimination or reduction of all pollutants in waste effluents as soon as possible and in no case later than December 31, 1975.

Particular attention should be given to control of significant sources of nutrients, toxic and organic substances.

- c) municipalities should provide adequate sewage treatment including disinfection of treated

sewage discharges as soon as possible and in no case later than December 31, 1975.

Priority should be given to the reduction of all significant sources of phosphorus with initial controls provided at Hawkesbury, Gatineau, Pte Gatineau, Hull, Ottawa, Nepean, Renfrew, Pembroke and Petawawa.

3. that a complete mass balance accounting be made of all chemicals used in industrial operations, especially toxic substances.
4. that the discharge of industrial wastes be temporarily curtailed if the water quality standards are likely to be violated. This would provide an immediate and ongoing measure to prevent gross pollution.
5. that in future treated effluent discharge proposals be considered in the context of maintaining the quality of water throughout the basin and protecting the existing and foreseeable uses of the river.
6. that the Canada Department of Public Works review present log driving practices with the objective of controlling the losses of bark and logs from the drives to prevent the obstruction of flow channels and interference with recreation.
7. that the governments of Ontario and Quebec enter into an agreement for the implementation of the needed pollution abatement programs to upgrade water quality in the Ottawa River; these arrangements should provide for a continuing review of
 - i) monitoring and surveillance programs including a water quality sentinel system.
 - ii) evaluation of compliance of discharges with the water quality standards and effluent requirements of the Ontario Water Resources Commission and the Quebec Water Board.
 - iii) legislation pertaining to improved control of environmental quality.

- iv) integrated measures to combat spills of oil and other hazardous substances.

8. research should be undertaken to:

- i) ensure that efforts are directed to determining the feasibility of removing mercury, wood debris, fibre and solids from the river where such materials are presently damaging the aquatic environment.
- ii) provide improved methods of forecasting water quality including water quality simulation modelling.

CHAPTER 2

BASIN DESCRIPTION AND RESOURCE USE

2.1 PHYSIOGRAPHY

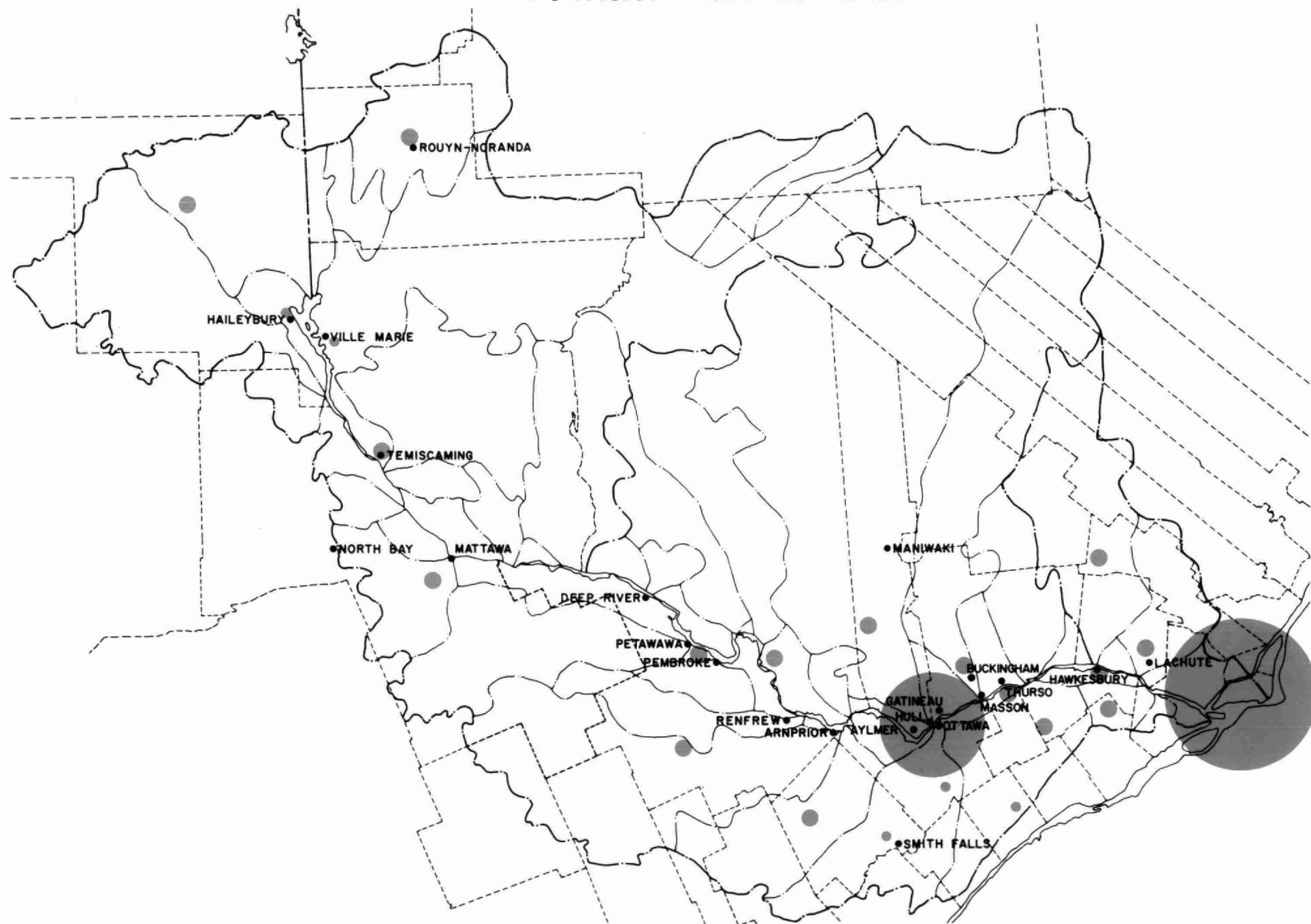
The Ottawa River drains a total area of 56,000 square miles located in eastern Ontario and western Quebec. The predominant features of the basin include the Laurentian and Algonquin highlands and a series of lowlands formerly occupied by the Champlain Sea. Each year an average of 34.5 inches of rain falls on the total basin with a runoff of 17.5 inches. A detailed physiographic description of the basin is included in Appendix B.

2.2 POPULATION PROJECTIONS

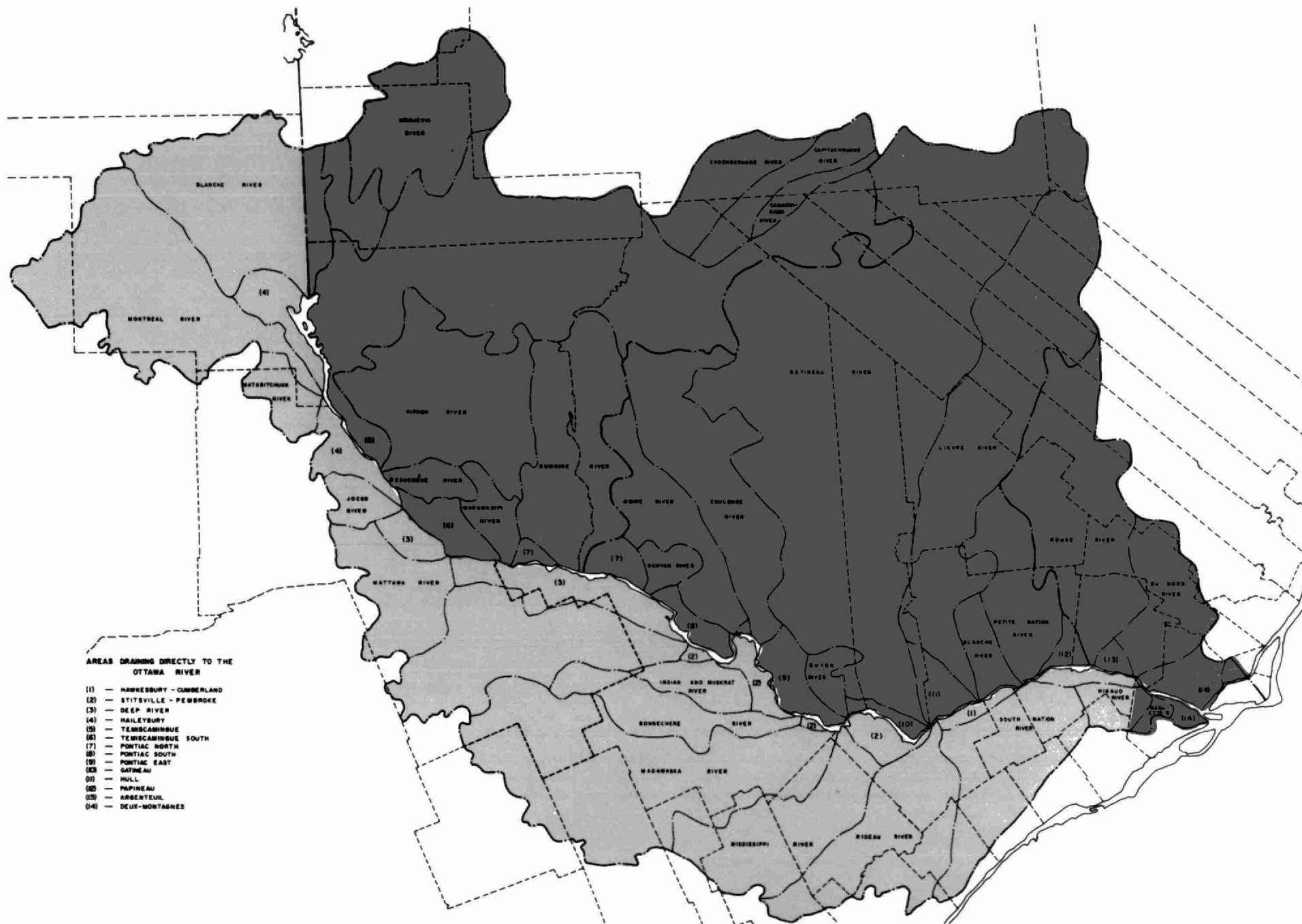
The Ottawa basin supports a diverse mix of economic activities; major industrial activities are generally confined to the urban areas while agriculture, recreation, and forestry are dispersed throughout the basin. Historically, each of these economic activities has influenced the growth of population in its own way. In recent decades, definite trends have emerged in each of these activity-areas, in turn generating changes in the distribution and size of population in the basin.

The urban-rural division of population outlined in Appendix C, by tributary basin, is summarized from the detailed information in Volume II of this report; the summary subdivides the population within each tributary basin into the constituent municipalities. The relative population distribution throughout the basin, including Montreal, is illustrated in Figure 2.2.1. The individual tributary basins, including areas draining directly to the Ottawa River are shown in Figure 2.2.2. Analyses of Dominion Census data from 1941 and earlier were undertaken and, in conjunction with available population projections, the estimates of 1991 population were produced. These projections recognize a continuing slow growth rate in the basin and, of greater significance, a continuing shift from farm areas and small hamlets to urban centres. These projections do not recognize a farm consolidation program on a scale greater than that already supported by governments. For Quebec, however, they incorporate a program of regionalization of small urban centres. The existing provincial and federal loan and grant programs, which aid in the location of industry in slow growth areas such as the Ottawa basin, at present represent an unknown factor in

FIG. 2.2.1
RELATIVE POPULATION DISTRIBUTION
WITHIN THE
OTTAWA RIVER BASIN



OTTAWA RIVER BASIN



industrial location. Data showing the effects of these programs are not yet available. The over-riding factor in urban growth in the basin remains as the National Capital Region. In terms of absolute numbers and rate of population growth, this urban area is expected to lead all others in the basin. Of secondary importance, is that portion of the basin adjacent to Metropolitan Montreal.

The summary data for urban and rural components of population by tributary basin indicates the location and nature of future demands for the water resources of the basin. The ratio of urban users to rural users is expected to change from 3:1 to 5:1 by 1991, with the total population increasing by 60 per cent. The urban segment of population, which was 1,165,000 in 1966, will have increased to 1,853,000 by 1991.

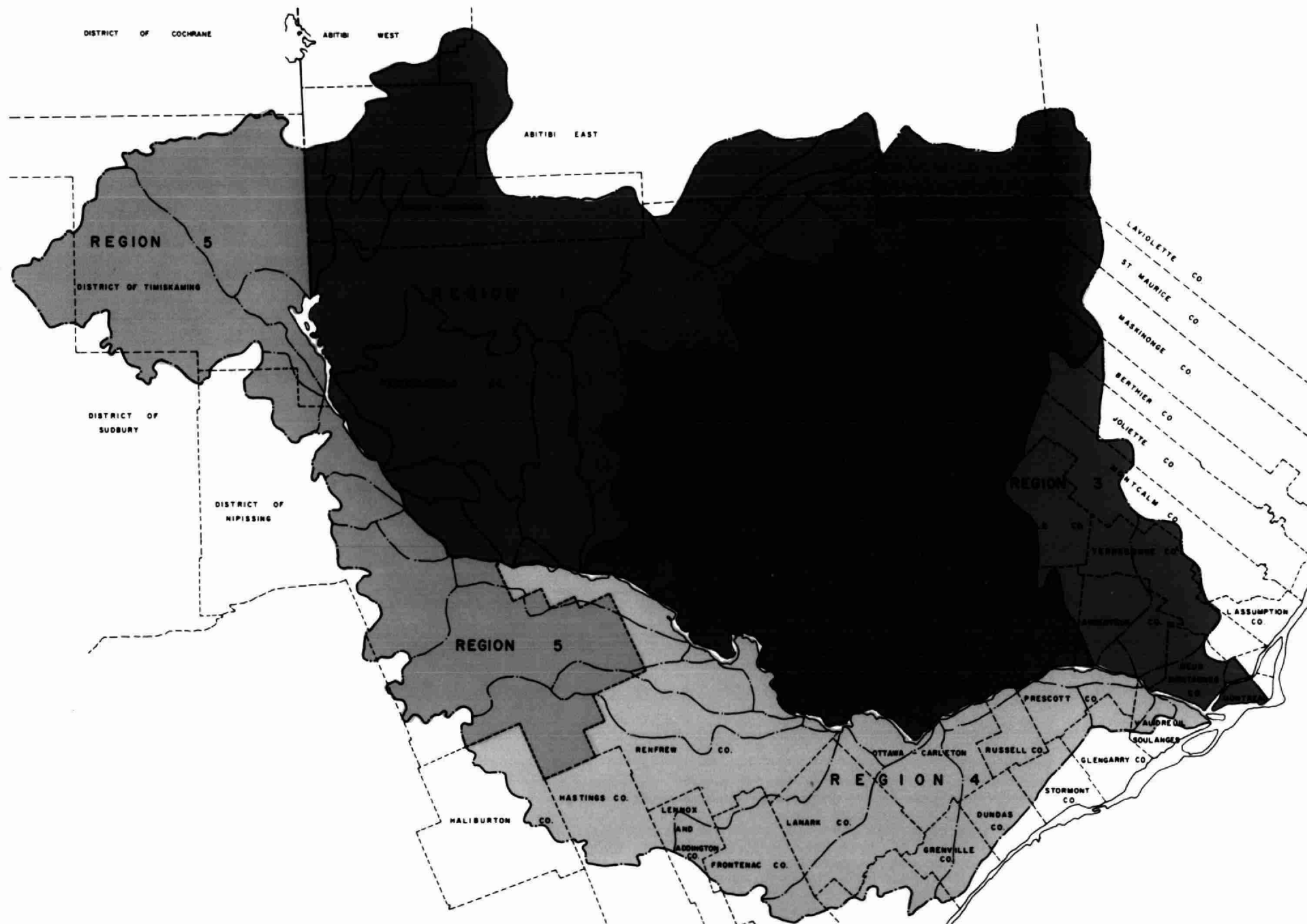
2.3 LAND USE AND DEVELOPMENT

The diverse mixture of activities and the demands that they exert on the water resources of the Ottawa River basin are more directly reflected in the pattern of land uses than in the size and distribution of population. For purposes of general description, the basins can be divided into five broad regions, two in Ontario, and three in Quebec (see Figure 2.3.1).

The Eastern Ontario Economic Region (Region 4) includes eleven counties from the Quebec border west to and including Renfrew county; parts of all of these counties drain to the Ottawa River. The Northeastern Ontario Economic Region (Region 5), composed of six districts, lies partly in the Ottawa River basin; portions of Nipissing and Timiskaming drain to the Ottawa River. In Quebec, Region 1 is situated in the most northerly portion of the basin and contains 12 tributary basins flowing to the Ottawa River. Region 2, containing 14 tributary basins, is centred on the National Capital and, like the Eastern Ontario Economic Region, is subject to the social and economic forces of the National Capital. Region 3, containing 6 tributary basins, is closely related to Metropolitan Montreal, and is expected to grow at a rate greater than the other two regions in Quebec.

Past urban growth in the Eastern Ontario Economic Region, has followed the demand of the agricultural industry for services in a dispersed, local form. Changes in agricultural technology, along with other factors, have caused a recent shift of increasing numbers of working age families to the large regional centres as well as the medium-sized local service

FIG.2.3.1
OTTAWA RIVER BASIN—ECONOMIC REGIONS



centres. Industries requiring only a small local labour force and limited production facilities have been able to locate in these medium-sized centres. The probable growth points include: Ottawa, Arnprior, Smiths Falls, Renfrew, Pembroke, and Hawkesbury. A higher level of servicing will likely be demanded of development in these centres. In most of the growth centres, anticipated growth to 1991 is extensive.

The northern areas of Nipissing and Timiskaming in Ontario and Region 1 in Quebec, have a considerably diminished incidence of urbanization compared to the downstream areas. The original reasons for the establishment of urban centres was largely to develop the natural resources in these areas such as mines and forests. At present many of these centres serve as supply points for tourist outfitters and private cottagers in addition to the mining and forest product industries. The forces driving urban growth in downstream areas are largely absent in the northern regions of the basin where the prosperity of the local resource-based industry has, and probably will, continue to determine the degree of future growth.

Region 2 centred on the National Capital, is both industrial and agricultural in character. The forces of changing agricultural technology and migration out of farming areas are producing urban growth primarily in the Metropolitan Hull area with more limited growth in Maniwaki and Mount Laurier.

The northern section of the region supplies pulpwood which is transported south via the major tributaries to the pulp mills located along the Ottawa River in the southern portion of the region. Within the region, raw materials are harvested, transported south and processed for shipment out of the region.

Region 3, on the fringe of Metropolitan Montreal, is more homogeneous than the other two Quebec regions. The proposed new international airport at Sainte-Scholastique is expected to produce accelerated growth in many small centres in the area including: Lachute, Calumet, Grenville, Brownsburg, Chatham, Carillon and Saint-Andre-Est. It is anticipated that the new airport will promote growth in the service industry and in the light manufacturing industry. The region is also noted as one of the most productive agricultural areas within the basin.

Additional information on Industry and Agriculture in the basin is presented in Appendix D.

2.4 POPULATION AND LAND USE TRENDS AS RELATED TO WATER QUALITY

Within the Ottawa River basin, the established trend is toward a population shift to the urban centres. Anticipated rural growth is likely to balance this migration from rural sectors, the net effect being a constant population level throughout the rural sections of the basin. Real growth occurring within the basin will essentially be within the urban centres, presently located along the river.

The above patterns of growth will be accompanied by an expansion of industrial development, the net effect being significant increase in the potential pollution pressures exerted on the river in urban areas such as the National Capital, Temiscaming, Pembroke and Hawkesbury. This trend will also be accompanied by an increased demand for other uses of the river such as water supply and recreation.

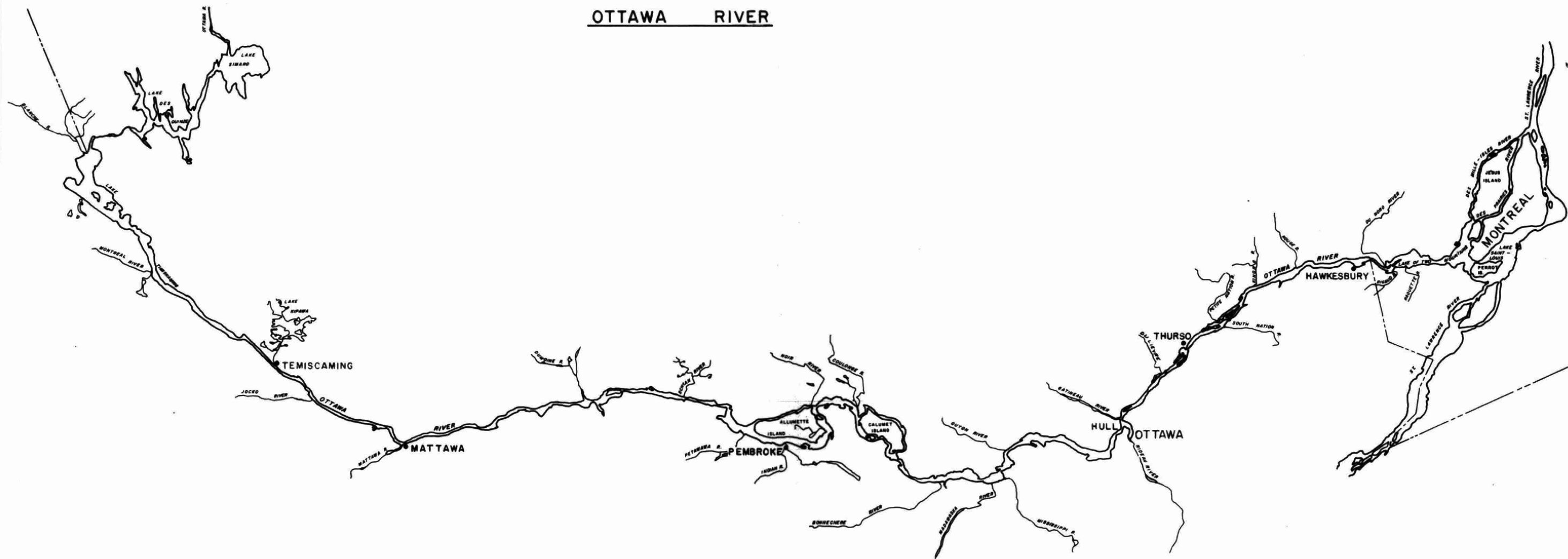
Without adequate water management practices that will promote the efficient use of water, this new demand will inevitably exceed the natural resource capability of the river.

2.5 WATER USES

The Ottawa River is used for many purposes, some of which conflict with others. Since 1900, the pulp and paper industry has located a number of mills along the river and hydro-electric power authorities have constructed several dams and generating stations. As a result, the previously accepted uses of the river have included industrial water supply, waste disposal, log driving and hydro-electric power generation. In more recent years, a greater emphasis has been placed upon using the river for domestic water supply and recreation as well as restoring a healthy balance of fish, aquatic life and wildlife to the entire river. THE MAIN GEOGRAPHICAL FEATURES, INCLUDING MUNICIPALITIES AND TRIBUTARIES, ARE REFERENCED ON FIGURE 2.5.1. FURTHER DETAILS ARE CONTAINED IN APPENDIX G.

Under natural conditions, the Ottawa River supports a wide diversity of plant and animal life much of which is not directly utilized by man. Consequently, the value of this resource is seldom fully appreciated. The production and storage of energy by plant life and the conversion of this energy through various levels of the food chain forms the nutritive basis for the production and maintenance of fish and other life. Also, it is this mechanism of energy conversion that is largely responsible for the maintenance of the quality of natural waters as we know it.

FIG. 2-5-1
OTTAWA RIVER



NOTE: FOR LOCATIONS NOT SHOWN ON THIS MAP, REFER TO APPENDIX "G"
WHICH PRESENTS A MORE DETAILED SERIES OF MAPS OF THE RIVER.

The use of surface waters for waste disposal and assimilation is largely dependent upon the biological processes of decomposition and dispersion of materials and energy throughout diverse aquatic plant and animal communities perhaps to an even greater extent than it is upon the physical processes of dispersion, dilution and downstream transport.

The maintenance of healthy, diversified and well-balanced communities of aquatic life is, therefore, basic to the management of water resources for multiple use.

Water Supply

The majority of municipalities adjacent to the Ottawa River obtain their domestic water supplies from surface water sources, with some of the smaller communities using ground water supplies. Small industries located along the river usually obtain water from a municipal system when possible. The larger industries, particularly pulp and paper mills, have their own surface water supplies. The Ottawa River supplies approximately 56 mgd to fifteen municipalities. Of this total, 46 mgd is used by the cities of Ottawa and Hull. Industrial water taking totals approximately 303 mgd; 200 mgd are taken directly from the Ottawa River and 103 mgd from its tributaries. The only significant industrial cooling water users are the Ontario Hydro nuclear power station at Rolphton and the Atomic Energy Nuclear laboratories at Chalk River, their combined total taking being 66 mgd. At present, permits have been issued only in Ontario for using Ottawa River water for irrigation; the total permitted taking amounts to approximately 1 mgd.

Recreation

The Ottawa River supports a wide variety of water-based recreational activities. While lakes on the system upstream of Lake Timiskaming have a high recreational potential, present use is less developed relative to downstream reaches owing to the low population densities and as yet, limited accessibility. In Lake Timiskaming and downstream, recreational uses of the river for the most part is high. Factors contributing to this use include the concentration of much of the population of the basin along the river; major highways and secondary roads which generally provide good access; the geographic position of the river adjacent to primary east-west transportation routes; and the presence of the national capital which exposes the region to a high level of non-resident tourist trade. Furthermore, the river, consisting of a series of natural and impounded lake-like expansions, is ideally suited to recreational uses and in itself comprises a very significant portion of the surface water area of the basin.

Specific recreational activities supported in all or part by the river include boating, camping, tourist resorts and cottage developments. The most intensive boating activities are in the section of the river downstream from the Des Joachims Dam with particularly intensive activity in the Ottawa-Hull area. Several boating and yachting clubs operate along this section of the river. Camping facilities are located along the length of the interprovincial section of the river. These areas provide public access for the use of the river and in conjunction with campsites, provide facilities directly related to recreational water use. Tourist resorts and establishments contribute both directly and indirectly to the recreational use of the river. Over 200 establishments capable of accommodating approximately 7,000 persons are located along the length of the river. Over 60 per cent of these facilities are located along the section of the river downstream from the Des Joachims Dam; of these facilities, nearly 70 per cent are located in Ontario. It is estimated that 5,000 cottages are located along the length of the river. Over 90 per cent of these cottages are owned by people residing permanently in municipalities located along the river. Particularly heavy cottage densities occur in the areas adjacent to Montreal and to Ottawa and Hull.

Electric Power

The Ottawa River basin has been intensively developed to facilitate the production of hydro-electric power. Within the St. Lawrence River and Great Lakes drainage basin, the Ottawa River ranks fourth in hydro-electric power production with a rated generation capacity of 1.8 million kilowatts. The rated capacities of the three hydro-electric producing rivers in the St. Lawrence River and Great Lakes drainage basin with a greater capacity than the Ottawa River are the Niagara River - 4.3 million kilowatts, the Manicouagan River - 4.0 million kilowatts, and the St. Lawrence River - 2.7 million kilowatts. The total generating capacity of all major power developments within the Ottawa River drainage basin, including tributaries, is 3.0 million kilowatts.

Waste Disposal

The severe pollution pressures that result from the discharge of inadequately treated municipal and industrial wastes presently threaten to destroy the water quality of the Ottawa River if permitted to continue. The main pressure is generated by the pulp and paper industry which discharges approximately 190 tons per day of suspended solids as well as organic wastes that consume over 1 million pounds of oxygen per day (the equivalent of the combined raw wastes of the metropolitan areas of Toronto, Montreal and Ottawa). Wastewater discharges from other

industries and municipalities increase the pollution pressure by contributing to the bacterial contamination and the nutrient enrichment of the river as well as adding to the excessive organic load from the pulp and paper industry.

In the past, the discharge of wastewater to the river has been accepted. Industries and municipalities have both agreed that treating wastewater was expensive. However, we must now accept the cost for treatment and recognize that the previous lack of treatment has, in fact, been an economic bonus for the waste dischargers. In the case of the pulp and paper industry, required treatment will mean costs of \$5-10 per ton of product or approximately 5 to 10 per cent of the product value.

Navigation

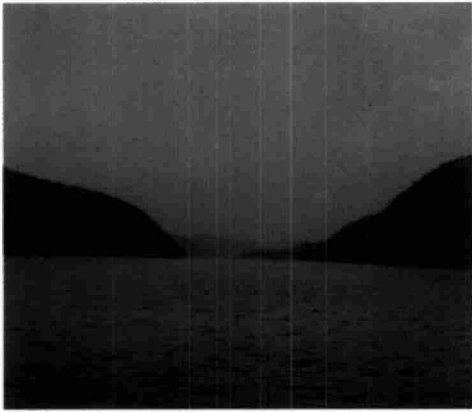
The Ottawa River was a main transportation route during early Canadian history. The first fur traders and explorers utilized the Ottawa River in their journeys to and from the west. In 1908, a Canadian government report was prepared proposing a ship canal from the St. Lawrence River to Georgian Bay via the Ottawa and Mattawa rivers. However, the proposal was never developed and the Welland Canal became the primary transportation route to the Upper Lakes, by-passing the Ottawa River system. At this time, navigation is primarily confined to recreational boating and log driving.

Fish, Aquatic Life and Wildlife

The many lakes and rivers within the basin support a wide variety of fish species, waterfowl and other aquatic life. Warm water fish species are common to most rivers and lakes while cold water species are found in many headwater streams and in the deep lakes which predominate in the Shield Region. Sport fish species of greatest importance include northern pike, walleye, largemouth and smallmouth bass and yellow perch; commercial fish species in order of importance, in terms of dollar value, are bait minnows, bullheads and sturgeon. Other commercial species include catfish, whitefish, suckers, sunfish, herring, eels, carp and perch. With the exception of sections of the river immediately downstream from industrial developments (particularly the section downstream from the Chaudiere Dam that has been contaminated by mercury), the river supports a viable sport and commercial fishery (see Appendix E).

As well as providing an excellent breeding habitat for waterfowl, the river is utilized to a considerable degree by waterfowl during spring and fall migrations.

PLATE I
THE OTTAWA RIVER



a) WILDERNESS



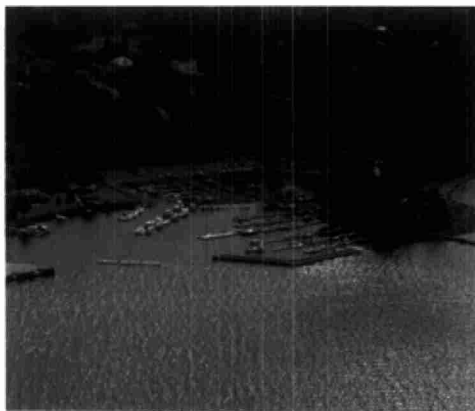
b) LAKES



c) BOATING



d) MARSHLAND



e) MARINAS



f) HYDRO - ELECTRIC POWER

PLATE II
PULP AND PAPER INDUSTRY



a) LOG SORTING



b) PULPWOOD STORAGE



c) BOOMING GROUNDS



d) MILL EFFLUENT



e) MILL COMPLEX

CHAPTER 3

WATER QUALITY PROBLEMS

3.1 WATER USE CONFLICTS

In the past, the use of the Ottawa River for water supply, waste disposal, log driving and hydro-electric power production has been accepted with little or no regard for the environmental consequences, particularly those resulting from the latter three uses. Water quality in several areas, having both recreational potential and the capability of supporting a healthy balance of fish and wildlife, has been degraded beyond the point at which these uses can continue.

The development of dependable transportation systems, particularly highways, and the additional leisure time now available to large portions of the populace have contributed to the need for improved water quality to cope with an increasing demand for recreation and water supply.

The major conflicts arising from these uses are discussed below.

Wastewater Disposal

Approximately 450,000 pounds of suspended solids are discharged to the Ottawa River daily. The pulp and paper mills along the river discharge 99 per cent (445,000 pounds) of this total in the form of wood chips, wood fibre and bark refuse. Extensive deposits of the wood solids discharged by various mills occur at points along the river. The logging operation of the Canadian International Paper Company, Kipawa mill, located upstream of the Timiskaming Dam, results in bark and log accumulations on the bottom of the river. Downstream of the dam the company discharges wood solids that have accumulated on the river bottom. On occasion, both of these accumulations of solids have interfered with the operation of the Timiskaming Dam by reducing the cross-section of the river channel and restricting the volume of flow that could pass through the dam.

Solids discharged from each of the pulp and paper mills and deposited on the riverbed downstream from the mill may destroy the normal habitat for bottom fauna and flora and cover potential fish spawning beds. The decaying solids exert an additional demand on the oxygen reserve of the river and produce compounds in concentrations that are toxic to fish and other aquatic life. In addition, these solids decay to produce compounds, including hydrogen sulphide and methane, in

concentrations that are toxic to fish and other aquatic life. Furthermore, aesthetics and recreational uses of the river are impaired by: 1) sludge banks located along the shores covering potential bathing beaches; and 2) unsightly mats of resuspended, partially decomposed, wood fibre. This problem is particularly evident for approximately 8 miles downstream from the Timiskaming Dam and downstream from Hull to the Carillon Dam.

Inorganic nutrients, particularly nitrogen and phosphorus, from municipal and industrial waste discharges, add substantially to background levels of enrichment and productivity in the river. Production of aquatic vegetation has reached nuisance proportions relative to most recreational pursuits in the many natural lakes on the system coinciding with the areas of greatest cottage density.

Soluble organic materials contained in municipal and industrial discharges deplete the oxygen resources of the river and provide organic nutrient materials that promote the growth of "slime" bacteria. These growths cover portions of the river bottom and interfere with the operation of the turbine cooling water systems at some of the hydro-electric generating stations located along the river. In addition, the slime growths are aesthetically displeasing; disrupt the normal bottom fauna; cause mortality in fish eggs, and clog water intakes and commercial fishing nets.

The organic wastes from the Kipawa mill deplete the dissolved oxygen levels in the section of the river from the Timiskaming Dam to the Des Joachims Dam. Similarly, organic waste discharges from municipalities and industries downstream from Ottawa deplete the dissolved oxygen reserves of the lower river. The depletion of the dissolved oxygen levels at various points along the river impairs the fishery by limiting the type of fish and bottom fauna and flora that can survive in the river.

Inadequately treated waste discharges cause bacterial contamination which interferes with the use of the river for bathing and swimming. This occurs locally in many areas upstream from the Chaudiere Dam and extensively along both shorelines downstream from the cities of Ottawa and Hull. In particular, extremely high levels of contamination occur downstream from Hull as a result of the discharge of large volumes of untreated municipal and slaughterhouse wastes from the city and from Canada Packers Limited.

Phenyl mercuric acetate has been used as a slimicide in the production of paper at two of the pulp and paper mills located along the lower river. The loss of significant quantities of the compound to the river has resulted in the

accumulation of mercury in the bottom sediments. This mercury has gained access to the food chain with a resulting accumulation in fish. Commercial fishing has been banned downstream from the Chaudiere Dam because of unacceptable levels of mercury in the fish flesh. In addition, sport fishermen have been advised to "fish for fun", and limit the consumption of fish taken from this section of the river.

In several instances, disagreements between waste dischargers and other water users have developed as a result of the water quality impairment being caused by discharges of excessive quantities of waste to the river. At some locations along the river, property values have decreased in recent years, primarily because of water quality impairment. Unsightly waste discharges not only depress property values, but present a poor image for an important recreational river. This is particularly true in the vicinity of the National Capital.

Log Driving

Since the nineteenth century, when large quantities of white pine were rafted down the Ottawa River, log driving has been the accepted mode of transporting logs. A significant quantity of the wood being driven becomes waterlogged and sinks, or floats partially submerged. Other logs break free from the booms and drift onto the shore where they accumulate. Floating logs create hazards for pleasure and commercial boating and for water skiing on the river. Often cottagers cannot use their beaches until they have removed accumulations of logs that are lost from the log drives. Routine maintenance work is required upstream from power dams to remove accumulations of sunken logs that restrict the hydraulic capacity of the dams. Furthermore, the presence of glancing and holding booms restricts access to several areas of the river.

In booming areas, a marked increase occurs in the concentration of fibre and bark in the water causing the blanketing of the riverbed with wood debris. The booming areas often correspond with potential spawning and fishing areas downstream from dam sites. The net result is the degradation of the area for fish spawning and impairment of the fishery.

Power Generation

There are seven hydro-electric generating stations and one control dam located along the interprovincial section of the river. The lake-like impoundments created by these dams increase the surface area of the river available for recreational boating and navigation. However, flow variations created by the peaking of the river to match power production to demand cause water

level fluctuations. This in turn conflicts with the boating and navigational uses that the Downstream from the Otto Holden Generation Station, daily fluctuations of as much as five feet are common. In other areas daily fluctuations are less, but seasonal water level variations are common. Impoundments tend to encourage. Navigation is further restricted by the lack of locks in the dams. Only the Hydro Quebec dam at Carillon provides a lock to permit the passage of vessels.

Impoundments created by the hydro-electric generating stations reduce the reaeration capacity of the river considerably. This reduction in reaeration capacity severely restricts the ability of the river to recover from demand exerted by oxygen-consuming wastes.

3.2 MATERIAL INPUTS AND SOURCES

The principal pollutants which contribute to the pollution pressures on the Ottawa River are organic wastes, settleable wood solids, inorganic nutrients and bacteria. The organic wastes are primarily attributable to the pulp and paper industry which discharges over 90 per cent of the 500 tons of BOD discharged to the river daily. Likewise, the bulk of settleable material originates from the pulp and paper industry. Nutrients are discharged in both industrial and municipal effluents. Bacterial contamination is primarily a municipal problem. The following sections discuss the material inputs to the Ottawa River from industries, municipalities and tributaries.

Municipalities

Of the thirty-eight municipalities located along the river, only eight provide adequate treatment to reduce their organic loads to acceptable levels. The daily discharge of organic waste from the 38 municipalities totals 69,500 pounds of BOD, which is approximately 6 per cent of the total BOD load being discharged to the river. Table 3.2.1 lists the organic characteristics of the discharges from municipalities in both Quebec and Ontario. These loads have been estimated from treatment plant records or population statistics at locations where no treatment exists.

Bacteriological impairment of the river results primarily from the discharge of municipal sewage containing excessive numbers of coliform organisms, and the after-growth of bacteria, including coliforms, in sections of the river where inadequately treated organic wastes are discharged. This occurs locally in many areas upstream from the Chaudiere Dam and

FIG. 3.2.1

MAJOR MUNICIPAL AND INDUSTRIAL DISCHARGES TO THE OTTAWA RIVER

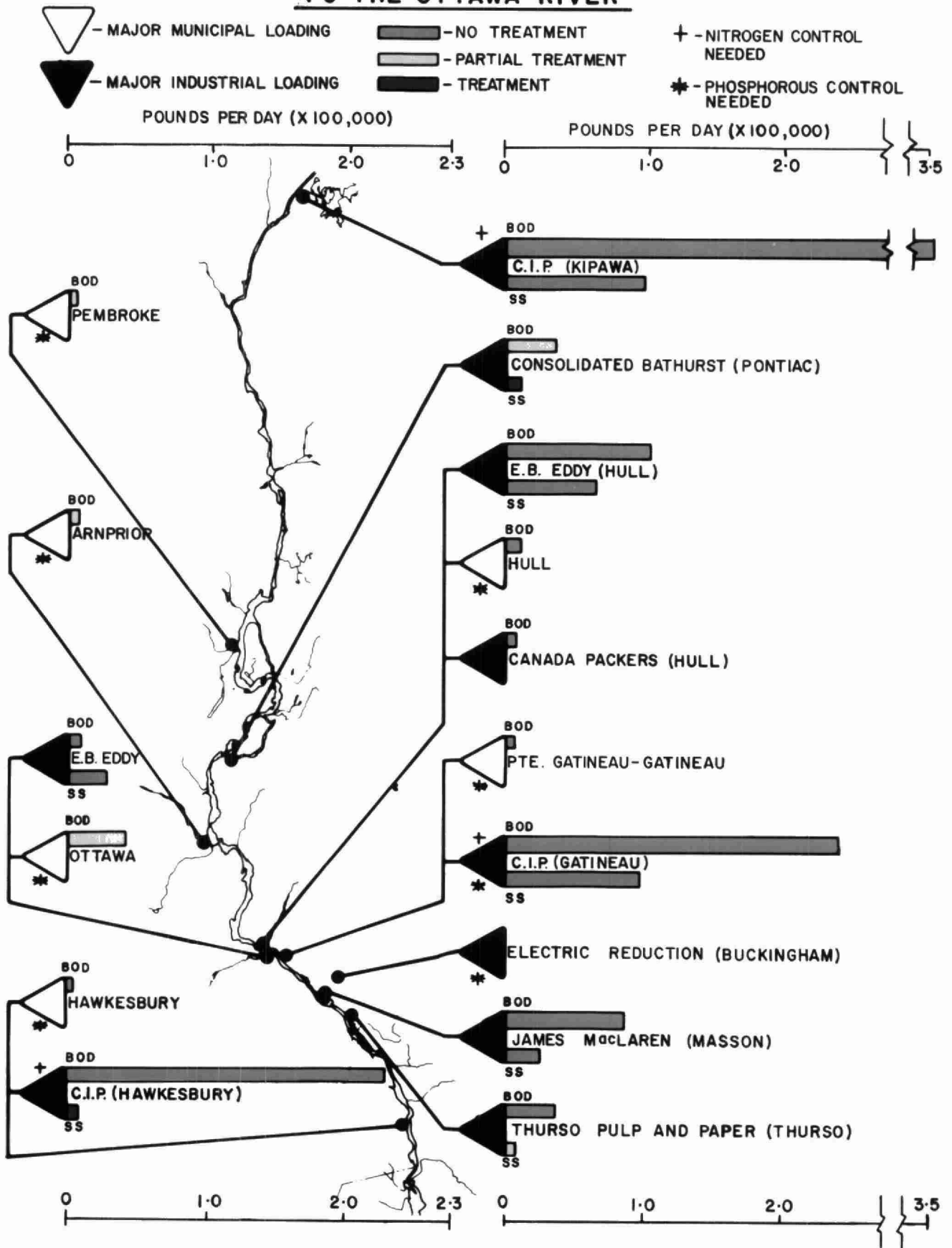


TABLE 3.2.1
MUNICIPAL DISCHARGE TO THE OTTAWA RIVER*

Municipality	River Mileage	Population Served	BOD Load lbs/day	Type of Treatment
Province of Quebec				
Ville Marie	421.6	2,400	410	None
Timiskaming	372.3	2,800	475	None
Chapeau	230.7	562	96	None
Fort Coulonge	211.4	1,815	18	Secondary
Campbell's Bay	202.8	1,150	200	None
Shawville	178.0	1,800	50	Secondary
Quyon	160.6	834	140	None
Aylmer	148.6	5,430	900	None
Des Chenes	135.4	4,070	660	Primary
Hull	130.0	60,500	10,000	None
Pte Gatineau	127.0	11,800	2,000	None
Gatineau	124.4	18,000	3,000	None
Templeton	121.1	3,216	545	None
Angers	116.0	615	104	None
Masson	112.5	2,300	391	None
Thurso	102.2	3,694	628	None
Papineauville	90.3	1,384	26	Secondary
Montebello	85.3	1,500	255	None
Fasset	82.1	525	90	None
Grenville	68	1,500	255	None
Quebec Totals		125,895	20,243	
Province of Ontario				
New Liskard	436	4,850		Secondary lagoon
Bucke Twp.	432	1,295		Septic tanks*
Haileybury	431	2,550	40	Secondary (contact stabilization)
Mattawa	336.3	1,400	8	Secondary (lagoon)
Deep River	270.4	5,100	170	Imhoff tanks
Chalk River	263.1	1,000		Septic tanks*
Buchanan Twp.	263	1,000	80	Primary
Petawawa	251.7	10,700	540	Primary
Pembroke	242.0	15,142	1,800	Primary
Renfrew	180.8	8,400	1,200	Primary
Arnprior	169.5	5,728	3,000	Primary
Nepean Twp.	139.2	24,000	500	Secondary (acti- vated sludge)

TABLE 3.2.1 (cont'd)

Municipality	River Mileage	Population Served	BOD Load lbs/day	Type of Treatment
Ottawa	121.8	320,000	40,000	Primary
Cumberland	112.5	1,000	100	Primary
Rockland	105.7	1,120	10	Secondary (lagoon)
Plantagenet	95.2	855		Septic tanks*
L'Orignal	73.0	1,295		Septic tanks*
Hawkesbury	68.0	9,049	1,600	None*
Ontario Totals		388,439	49,255	

Note: River mileages are measured along the centreline of the Ottawa River commencing at Mile 0.0, the confluence of the Ottawa River with the St. Lawrence River east of Montreal Island.

+ Quantities measured or estimated in waste effluent at the point of entry to the river.

* Provincial project (sewers and sewage treatment) under development by the Ontario Water Resources Commission.

extensively along both shorelines downstream from the cities of Ottawa and Hull.

Municipal wastes are one of the principal contributors of inorganic nutrients to the Ottawa River. Contributions of total phosphorus from municipal waste sources are 5,200 pounds per day (based on estimated concentrations for raw, primary and secondary effluents of 9.5, 6.5 and 5 mg/l, respectively). Approximately 43 per cent of the total municipal phosphorus load is contributed by the cities of Ottawa and Hull. It is estimated that municipal effluents contribute 19,000 pounds per day of nitrogen (as total N).

Industries

Industrial waste discharges, principally from the pulp and paper industry, account for over 90 per cent of the oxygen-consuming wastes and 99 per cent of the suspended solids being discharged to the river. The industrial dischargers, listed in Table 3.2.2, contribute over 99 per cent of the total industrial waste loadings discharged. Several smaller industries, discharging less than 1 mgd, are listed in Table 3.2.3.

Significant quantities of nutrients are discharged to the river as components of industrial wastewater. A total of 1,800 pounds per day of phosphorus (as total P) can be attributed to the pulp and paper mills and the Electric Reduction Company at Buckingham. Inputs of nitrogen (as total N) from the pulp and paper industry are in the order of 50,500 pounds per day. Most of this nitrogen originates from the ammonia based sulphite pulping process employed at the Kipawa and the Hawkesbury mills of the Canadian International Paper Company. The paper making process employed at the other mills contributes relatively little to the total nitrogen levels.

Small quantities of radioactive materials are discharged to the Ottawa River from the Rolphton Nuclear Power Plant and the Chalk River Nuclear Laboratories. Regular water quality monitoring of the river has indicated no significant increase in background levels of radioactivity as a result of these discharges.

Dredging on the Ottawa River is limited to one commercial operation and a number of channel improvement projects undertaken by the Canada Department of Public Works. The resulting resuspension of bottom deposits from the dredging operations is not considered to be significant.

In the past, the Hull Mill of the E. B. Eddy Company and the Gatineau Mill of the Canadian International Paper Company

TABLE 3.2.2

MAJOR INDUSTRIES DISCHARGING TO THE OTTAWA RIVER+

INDUSTRY	River Mileage	Data Source	Discharge mgd	BOD lbs/day	Suspended Solids lbs/day
PULP AND PAPER MILLS					
Canadian Inter- national, Kipawa (Sulphite)	372.3	1	84.2	258,700	90,700
		2	95	341,800	130,400
		3		410,000	
		4	75.4	386,000	82,200
Consolidated Bathurst, Pontiac (Kraft)	188.7	1	20	37,500	-
		2	24.4	41,700	17,900
		4	14.5	36,000	17,000
E. B. Eddy, Hull (Sulphite)	129.9	1	19.1	121,240	43,800
		2	24.2	100,300	73,000
		4	30.8	100,300	73,000
E. B. Eddy, Ottawa (paper mill)	129.9	1	4.6	5,200	25,600
		2	4.2	5,600	25,200
Canadian Inter- national paper Gatineau (Sulphite)	124.7	1	44.7	201,000	98,700
		2	50.4	245,000	103,100
		4	35.5	282,000	86,800
James MacLaren Masson (Sulphite)	113.3	1	21.1	34,000	8,100
		2	28.3	49,500	20,700
		4	9.6	50,200	25,400
Thurso Pulp and Paper, Thurso (Kraft)	102.8	1	14.7	21,800	15,700
		2	15.1	41,000	63,000
		4	12.5	38,256	7,800
Canadian Inter- national paper, Hawkesbury (Sulphite)	68.0	1	24.0	249,000	18,000
		2	21.3	205,000	9,000

TABLE 3.2.2 (cont'd)

INDUSTRY	River Mileage	Data Source	Discharge mgd	BOD lbs/day	Suspended Solids lbs/day
MEAT PACKING					
Canada Packers Hull (Abattoir)	127.9	2	0.74	8,500	4,300
INDUSTRIAL COOLING					
Ontario Hydro, Rolphton (nuclear reactor)	281.0		26		
Atomic Energy of Canada (nuclear laboratories)	263.1		40		

DATA SOURCE:

1. 1968 Ottawa River study industrial surveys
 2. 1969 Ottawa River study industrial surveys
 3. 1969 Assimilation study surveys
 4. "Report on Effluent Conditions of the Pulp and Paper Mills in Quebec - Resurvey for the year 1969".
- + Quantities measured or estimated in waste effluent at the point of entry to the river.

TABLE 3.2.3

INDUSTRIES DISCHARGING LESS THAN 1 MGD
TO THE OTTAWA RIVER AND TRIBUTARIES⁺

Industry	River Mileage	Discharge (mgd)	Waste Characteristic	Type of Waste
QUEBEC				
Hilton mines	165	.6	High suspended solids	Iron mine waste
Quyon Farmers Corp.	160.6	.005	60 lbs/day BOD	Butter factory
Hanson Mills	130	.022	120 lbs/day BOD	Textile
Co-operative Agricole de Papineau	95.2	.13	770 lbs/day BOD	
Hand Chemical	90.3	.013	20 lbs/day BOD	Wood working
Papineauville Lumber	90.3	.003	40 lbs/day BOD	
Montebello Metal	85.3	.005	10 lbs/day BOD	Metal working
Arnold Farms	68.0	.002	20 lbs/day BOD	Farm wastewater Sawmill & sani- tary
Scierie Georges Dansereau & Fils	68.0	.001	10 lbs/day BOD	
ONTARIO				
Canada Veneers	242.3	.036	120 lbs/day BOD 100 lbs/day Sus- pended solids	Wood working
Dominion Mag- nesium	189.0	.645	7 mg/l Chromium as Cr	Mine & Smelter
Haley Indus- tries	189.0	.065	40 mg/l Chromium as Cr	Metal working
Union Carbide of Canada	169.5	.210	15 lbs/day BOD 20 lbs/day Sus- pended solids	Textile (nylon fibre produc- tion)

+ Quantities measured or estimated in waste effluent at the point of entry to the river.

discharged quantities of phenyl mercuric acetate to the river. The use of mercury has now been discontinued. However, bottom sediments contain a significant reserve of mercury which will prolong the problem of mercury contamination of fish flesh.

Chromium is known to exist in the effluents of the Dominion Magnesium and the Haley Industry plants (Table 3.2.3). Bioassays have not been conducted on these effluents to determine the status of compliance with the water quality standards.

Each year, approximately 60,000 cords of wood are lost throughout the basin while being floated down river during the annual log drive. This represents about six per cent of the total quantity of wood transported on the rivers of the basin. This wood either sinks to the bottom, some of it collecting behind the dams on the river, or accumulates along the shorelines of the rivers used in the log drive. It is necessary to periodically remove sunken logs from behind the dams located along the river to prevent an accumulation of wood which would reduce the intake cross-section of the dam and also the flow which can pass through the structure. In addition, bark and fibre lost from floating logs contribute to the suspended solids loading carried by the river. In booming areas, this often amounts to a significant load which causes the blanketing of sections of the river bed.

Tributaries

The overall effect or net input of a tributary to the Ottawa River depends on its location, flow and chemical characteristics. In many cases, it is difficult to assess the tributaries as a source or input of oxygen and oxygen-consuming material (BOD) since the concentration of both BOD and dissolved oxygen could be higher in the tributary than in the river. Although the higher levels of dissolved oxygen would be an asset, the increased BOD would constitute a load. The Mattawa, South Nation, Rouge, Gatineau and Du Lievre rivers are generally beneficial inputs with respect to oxygen, the Gatineau and the Du Lievre rivers being particularly beneficial in view of their substantial flows. While the other major tributaries (see Table 3.2.4) generally have no effect on the river, the Rideau River contributes a net load of BOD and has lower concentrations of dissolved oxygen than the Ottawa River at that point. The total load of nitrogen and phosphorus to the river from these tributaries amount to approximately 7,000 pounds per day total phosphorus (as P) and 105,000 pounds per day total nitrogen (as N). This is an increase over the expected natural background level of about 3,000 pounds per day total phosphorus (as P) and 25,000 pounds per day total nitrogen (as N).

TABLE 3.2.4

CONTRIBUTIONS OF MAJOR TRIBUTARIES TO THE OTTAWA RIVER*

Tributary	Mean Annual Flow (1968-1969)	Year	Average Concentrations (mg/l)			
			DO	BOD	Total N	Total P
Mattawa River (RM 336.7)	925	1968	9.4	1.1	.44	.03
		1969	10.1	1.4	.44	.02
		1970	9.0	1.0	.57	.02
Petawawa River (RM 251.7)	1,610	1968	8.1	1	.49	.03
		1969	11.1	1.8	.42	.03
		1970	10.8	1.1	.46	.01
Madawaska River (RM 169.4)	3,140	1968	10.2	1.5	1.05	.03
		1969	11.4	1.7	.49	.02
		1970	9.8	1	.54	.04
Mississippi River (RM 165.3)	1,550	1968	9.2	1.4	.75	.05
		1969	10.8	1.1	.7	.03
		1970	9.7	1.1	.81	.05
Rideau River (RM 128.1)	1,400	1968	9.6	2.3	1.38	.11
		1969	6.8	2.4	.75	.07
		1970	5.9	1.6	1.14	.07
Gatineau River (RM 127.3)	13,100	1968	8.3	.8	.41	.03
		1969	11.1	1.2	.43	.03
		1970	10.4	1.3	.58	.02
Lievre River (RM 113.3)	5,300	1968	8.8	1.1	.45	.11
		1969	10	.94	.42	.09
		1970	10.9	1.2	1.37	.07
South Nation River (RM 95.0)	1,450	1968	7.2	2.6	1.25	.19
		1969	8.2	2.9	1.68	.13
		1970	8.1	2.2	1.15	.15
Rouge River (RM 73.2)	2,950	1968	9	1.6	.68	.02
		1969	11.4	.8	.57	.03
		1970	10.4	1.2	.36	.01

* Quantities measured in tributaries at point of entry to the river.

Inorganic fertilizers and chemicals have limited use in the Ottawa River basin and subsequently, have not contributed significantly to the overall nutrient enrichment of the system.

The forested nature of many of the tributary basins, and particularly the presence of large swamps and peat bogs contribute to the high levels of colour in the waters of some tributaries. This is particularly true of the Du Lievre River.

3.3 WATER QUALITY EVALUATION

This section of the report summarizes the physical, chemical, biological and bacteriological aspects of the quality of the Ottawa River based on information derived from routine monitoring carried out in 1968, 1969 and 1970 and from special studies undertaken in 1968 and 1969. Important findings are presented for each of the zones along the interprovincial section of the river with comments on the conditions arising in Zone 1 as a result of upstream discharges.

The river has been subdivided into six different zones. The section of the basin downstream from the Carillon Dam and the headwaters of the river lie completely within the Province of Quebec. These two areas have been designated as Zones 1 and 6, respectively. Zones 2,3,4 and 5 make up the 383 mile length of the interprovincial section of the river. Zone 2, downstream from Ottawa and Hull, is the most intensively developed section of the river and presently exposed to the greatest pollution pressures. Zone 3 is the section of the river upstream from the City of Ottawa supporting a high degree of recreational development; Zone 4 is the section of river from Des Joachims to Temiskaming where a good recreational potential is presently limited due to the discharge of excessive quantities of organic and solid wastes; Zone 5 is the section of the river known as Lake Timiskaming, which supports an excellent fishery as well as having a good potential for recreational development. In the Discussion, significant alterations in water quality are considered relative to contributing inputs and the effects of each on the various uses of the river.

For further details pertaining to water quality evaluations, the reader is referred to Appendix F of this report.

ZONE 5

The only significant waste discharges to this section of the river are those of the three small municipalities along the upper 20 miles of Lake Timiskaming. These discharges create limited local water quality problems but do not affect the overall quality of the zone.

Survey and monitoring results in the lower portion of the zone did not reveal significant impairment of water quality. Physical, chemical and biological characteristics were typical of natural oligotrophic waters for the region. Secchi disc readings were relatively low, this undoubtedly being the result of high colour in view of the low levels of turbidity. Monitoring results indicated low levels of total alkalinity at 20 mg/l (as CaCO_3); however, these values comply with the proposed standard (see Chapter 4) for this zone of the river.

ZONE 4

Waste discharges, mainly from the Kipawa mill of the Canadian International Paper Company, resulted in considerable chemical and physical impairment of the river with an associated change in the composition and abundance of the benthic communities.

Coarse woodwaste material from this mill formed sludge deposits which completely blanketed the river bottom for a distance of six miles downstream from the outfall, while high concentrations of suspended wood fibre were measured up to ten miles downstream. Floating sludge mats and odour problems associated with the anaerobic decomposition of these bottom deposits were frequently observed in this same region.

Decimation of the bottom fauna and abundant slime growths were found in the upper portion of the zone. The damage to normal bottom fauna communities extended for a distance of about 43 miles downstream before complete recovery occurred. Increased levels of sulphur bacteria were measured in the water and sediment downstream from the outfall of the mill.

Oxygen demanding wastes discharged by the Kipawa Mill caused a significant depletion of dissolved oxygen. A minimum level of 5 mg/l (55 per cent saturation) occurred approximately 55 miles downstream of the discharge; complete recovery to saturation levels was not observed until the lower end of the zone. These conditions were measured during early August when flows were 20,000 cfs (the anticipated low flow for this zone is 10,000 cfs).

There are several small municipal waste discharges to the river in this zone which do not appear to affect the bacteriological quality of the water. With the exception of some high levels of enterococci at the dams at Temiscaming and Des Joachims, the river was suitable for swimming and bathing in Zone 4.

ZONE 3

In general, survey results indicated satisfactory water quality for most river uses throughout the zone.

Average concentrations of dissolved solids, turbidity, colour and dissolved oxygen were similar to those recorded in the lower portion of Zone 4 and were within the limits of the standards proposed for the zone. Although waste discharges from the Consolidated Bathurst (Pontiac) Mill exerted a significant demand on the oxygen resources of the river, the dissolved oxygen levels were not below 6 mg/l. This level would probably be approached under critical conditions of water temperature and flow.

Average concentrations of inorganic nutrients were low and did not reflect significant overall enrichment related to industrial or sanitary waste inputs in the area. However, in the natural lakes of the zone, the levels of nutrients were sufficiently high to sustain large standing crops of algae and rooted aquatic plants.

An increasing downstream trend in average concentrations was noted for total solids, total hardness, conductivity, sulphates and total alkalinity. Iron levels increased in a downstream direction to a high at the Des Chats Dam; further downstream they decreased to levels which were typical of the upper portion of the zone.

Significant impairment of water quality in local areas was indicated by: 1) alterations in bottom fauna communities below waste discharges from the City of Pembroke and the Town of Arnprior; 2) development of slime growths attributable to organic nutrient enrichment from the Pontiac Mill of Consolidated Bathurst; 3) elevated levels of suspended wood fibres and bark accumulations over bottom deposits in areas of intensive log driving activity; and 4) high bacterial counts in excess of levels acceptable for swimming and bathing below sanitary waste discharges from Pembroke and several other locations in lower Lake Deschenes.

ZONE 2

The river, in Zone 2, was grossly contaminated primarily by the waste discharges from six pulp and paper mills and from the major urban centres of Ottawa and Hull. Little evidence of recovery was noted and for much of the zone the value of the river for most uses was seriously limited. A downstream increase was observed in colour and turbidity and total dissolved solids were generally high. Both tributary inputs and waste discharges contributed to this trend.

Adverse conditions caused by pulp and paper mill waste discharges, included: extensive bottom sludge deposits and floating sludge mats; high concentrations of suspended wood fibre and reduced transparency as indicated by low secchi disc readings; elevated levels of BOD, ammonia and conductivity; excessive slime growths; odours; and significant mercury contamination of sediments and flesh of important sport and commercial fish species. In addition, dissolved oxygen levels at several points were commonly as low as 5.0 to 5.5 mg/l and during a July study, under conditions of somewhat restricted river flow, concentrations decreased downstream to a low of 4.3 mg/l at the Carillon Dam. Furthermore, composition of bottom fauna communities was significantly altered from natural conditions throughout much of the zone particularly in areas of greatest sludge (wood chip and fibre) deposition.

Municipal sanitary wastes caused an increase in the level of inorganic nutrients and contributed to the severe bacterial contamination in some areas. Average nitrate concentrations increased to a high of 0.16 mg/l at the Carillon Dam. Highest total phosphorus concentrations occurred near Cumberland largely influenced by wastes from the cities of Ottawa and Hull and by inputs from the Electric Reduction Company at Buckingham (via the Du Lievre River).

Bacterial contamination of both shorelines of the river was extensive throughout the zone. Raw waste discharges from Hull, Pointe Gatineau and Gatineau; effluent from the Ottawa primary sewage treatment plant; and untreated waste discharges from the Canada Packers slaughterhouse in Hull were the principal sources of the bacterial contamination. Inadequately treated waste discharges from other municipalities downstream from the Ottawa-Hull area contributed significantly to the contamination of both shorelines.

In recent years, contamination of the river by numerous oil spills in the vicinity of Ottawa and Hull has been documented. In the course of recent work on the river, oil

slicks were common throughout the thirteen miles downstream from the Chaudiere Dam.

ZONE 1

In general the water quality of Zone 1 was similar to that found in the lower portion of Zone 2.

The low point in the dissolved oxygen profile for the lower Ottawa River occurred at the upstream end of the zone during late July and early August; the low point shifts further downstream during winter months. The additional factor of excessive nutrient enrichment and the associated high productivity has resulted in severe oxygen depletion under ice cover in bays of the Lake of Two Mountains where water exchange with the main flow of the river is minimal.

The relative abundance and composition of bottom fauna communities were similar to those observed in the forebay of the Carillon Dam. A decrease in overall diversity and an increase in tolerant sludge worms in the section from 5 to 15 miles downstream from the dam reflected low levels of dissolved oxygen.

The bacterial levels throughout the zone were for the most part within the limits defined by the proposed standards (see Chapter 4). In the vicinity of Oka, fecal coliform levels averaged 100 organisms per 100 ml, and enterococci levels averaged 48 organisms per 100 ml for data obtained during 1969.

DISCUSSION

This investigation has clearly defined areas of gross degradation of water quality in the upper portion of the river downstream from the Town of Temiskaming and in the lower portion of the river downstream from the cities of Ottawa and Hull. The overall quality of Lake Timiskaming was excellent. In the section of the river downstream from the Des Joachims Dam to the cities of Ottawa and Hull, recovery from observed effects of pollution was complete. The water quality was generally satisfactory in this stretch of the river with the exception of several significant but locally confined areas of impairment.

The following discussion, which pertains to those aspects of water quality that were most seriously degraded, is intended to clarify the relative contribution from specific waste sources and to examine the effects of each on the various uses of the river.

By far the most obvious impairment of water quality, in terms of the general public's appreciation of conditions in the river from visual observations and the most damaging with respect to limitations on most water uses, results from the discharge of substantial volumes of untreated pulp and paper mill effluents. These wastes include suspended solids (bark, wood chips and fibre), soluble organic compounds, colour and odour causing materials, toxic components and in some instances mercurial compounds.

The highest concentrations of suspended solids, and the greatest sludge deposition in the river occur as a result of inputs from the Kipawa mill of the Canadian International Paper Company at Temiscaming and the Hull mill of the E. B. Eddy Company and the Gatineau mill of the Canadian International Paper Company in the Ottawa-Hull area. Lesser effects are produced by the Masson mill of the James MacLaren Company (settling occurring in the Du Lievre River and Clement Bay), the Thurso mill of the Thurso Pulp and Paper Company and Hawkesbury mill of the Canadian International Paper Company, located on the lower river, and the Pontiac mill of the Consolidated Bathurst Company at Portage-Du-Fort. Effluents from the latter three mills are lagooned before discharge. However, sludge deposits and suspended fibre concentrations are increased by each discharge with the exception that significant sludge deposits do not occur downstream of Consolidated Bathurst.

Adverse effects of solids deposition related probably to a combination of physical factors, benthal oxygen depletion and sulphide toxicity on benthic biota of the river have been demonstrated in this study. Although abundance of tolerant and semi-tolerant organisms is usually increased, valuable food species for fish and waterfowl are lost. Further adverse effects on fish production result from the physical destruction of potential spawning beds and toxicity to fish eggs and fry. Floating sludge mats originating from resuspended bottom sludge and the evolution of odourous methane and hydrogen sulphide gasses seriously impair the aesthetic quality of the first six miles of river downstream from Temiscaming and a total of 29 miles of river in the Ottawa to Carillon reach. Adverse effects of suspended fibre include: aesthetic impairment; increased turbidity affecting light penetration and related primary production; clogging of water pumps of outboard motors and of municipal, industrial and other water supply systems; fouling of commercial fishing gear (gill nets); and reduced survival rates of juvenile fish and slower growth rates of adult fish.

Soluble organic compounds discharged in pulp and paper mill effluents account for approximately 90 per cent of the total oxygen demand load on the river. These inputs, plus additional

oxygen demand created by benthic sludge deposits and loadings from sanitary and other industrial waste sources, have been shown in this study to deplete dissolved oxygen resources in both the lower river and the reach from Temiscaming to Deux Rivieres to levels unsuitable for the optimum maintenance of warm water fish species. Soluble organic compounds further impair water quality by creating aesthetically undesirable conditions of colour and odour at least locally below mill outfalls. Threshold odour values in excess of those generally considered aesthetically acceptable occur below all mill discharges in the lower river. Values are highest and extend further downstream below discharges from the Gatineau mill of the Canadian International Paper Company and Thurso mill of the Thurso Pulp and Paper Company. Wood sugars and other organic compounds promote slime growths below all mill discharges to the river. These growths, in addition to further impairing the aesthetic value of the river, adversely affect hatching success and survival rates of fish eggs and fry and in conjunction with wood fibres create clogging problems. Problems of this nature resulting in increased maintenance costs have been noted to occur at the Otto Holden and Chenaux hydro-electric generating stations, these being directly related to upstream waste discharges from the Kipawa mill of the Canadian International Paper Company and the Pontiac mill of the Consolidated Bathurst Company respectively.

Other effects related to dissolved solids include acute and sub-acute toxicities to fish and other aquatic life and tainting of fish flesh. These effects, as far as is known, are related only to Kraft process wastes. In view of the diversity of fish species, acute toxic factors do not appear to be significant. The many sub-lethal effects which are possible, however, may be affecting fish production. Although studies have not assessed tainting of fish flesh, the sizeable sport fishery and marketability of commercial fish products (except for those contaminated with mercury) would suggest no adverse effect in this regard.

With regard to the noted mercury contamination of the lower river, the only known inputs have occurred as a result of the use of mercurial compounds as slimicide agents by E. B. Eddy (Hull) and the Canadian International Paper Company (Gatineau). Discharge of these materials has resulted in significant contamination of several fish species in the river downstream from the Chaudiere Dam which, in 1970, led to the closure of commercial fisheries and recommended restrictions on sport fishing in the Ottawa River downstream from the Chaudiere Dam. While levels, on the basis of sediment analysis, were highest downstream of the above named companies, elevated levels approaching 1.0 mg/kg were common in sediments throughout Zone 2. On the basis of the extensive area of contamination and the

availability of mercury to fish through the food chain, it is possible that levels in fish flesh in excess of presently acceptable limits may persist for many years.

Waste discharges from municipalities and certain industries contribute significant amounts of nitrogen and phosphorus to the river. These inorganic nutrients add substantially to the background levels of enrichment and productivity of the river. Although total nitrogen and total phosphorus have been found in increasing amounts moving downstream from Lake Timiskaming, the greatest increase occurs in Zone 2 below Ottawa and Hull. Some high concentrations have been recorded in local areas, in particular downstream from the Du Lievre River to Thurso, where waste effluents have not completely mixed with the river. The following summary indicates the concentrations of phosphorus and nitrogen found at various locations along the river:

LOCATION	CONCENTRATION (mg/l) +	
	Total Phosphorus	Total Nitrogen
Timiskaming Dam	.02	.48
Des Joachims Dam	.02	.50
Britannia (Ottawa)	.03	.43
Hiawatha Park	.04	.61
Thurso	.05	.66
Carillon Dam	.04	.74
Oka	.04	.65

+ Monthly monitoring data 1968-1970

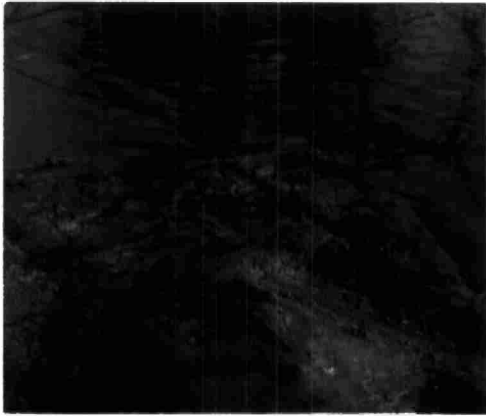
General observations indicate high levels of production of algae and rooted aquatic plants in the natural lakes of Zones 3 and 1. Aquatic plant production is presently considered to be of nuisance proportions relative to some recreational activities, particularly in these zones. Additional inputs of inorganic nutrients can be expected to further aggravate these conditions. Primary productivity levels which appear to be extremely high in the Lake of Two Mountains (Zone 1) are probably governed to a large extent by major upstream inputs of nutrients. Winter oxygen depletion in shallow, productive bays of the lake is undoubtedly caused by excessive organic decomposition in the absence of reaeration.

Inadequately treated waste discharges cause bacterial contamination which interferes with the use of the river for bathing and swimming. This occurs locally in many areas upstream from the Chaudiere Dam and extensively along both shorelines downstream from the cities of Ottawa and Hull. In particular, extremely high levels of contamination occur downstream from Hull

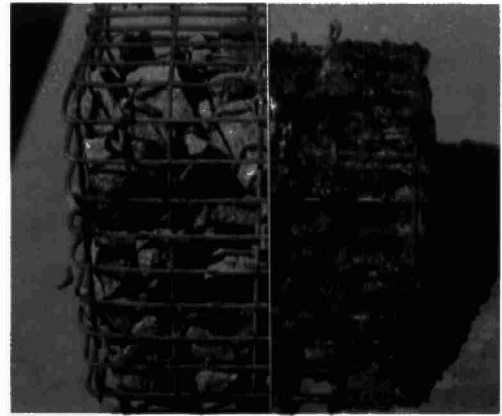
as a result of the discharge of large volumes of untreated municipal and slaughterhouse wastes from the city and from Canada Packers Limited; similarly bacterial contamination occurs downstream from the discharge of the primary sewage treatment of the City of Ottawa.

PLATE III

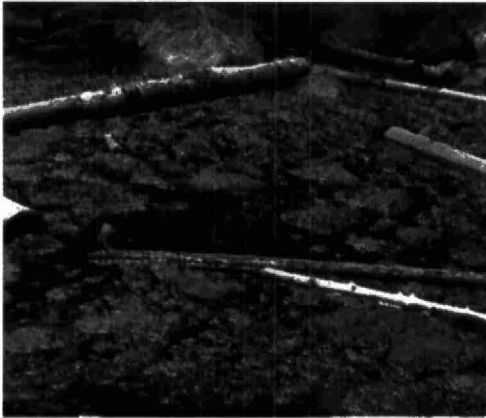
WATER QUALITY PROBLEMS



a) SLAUGHTERHOUSE WASTES
IN BREWERY CREEK

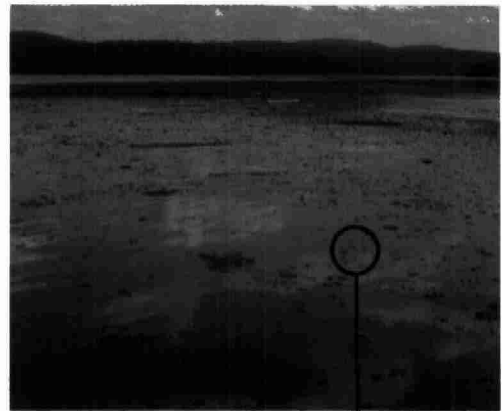


b) PROLIFIC SLIME GROWTHS



c) SLUDGE MAT AND LOG

d) DECAYING BOTTOM SLUDGE
DOWNSTREAM FROM TEMISCAMING



e) INTAKE SCREEN PROBLEMS AT
THE CHENAUX GENERATING
STATION



CHAPTER 4

WATER QUALITY CONTROL

4.1 PROPOSED WATER QUALITY STANDARDS FOR THE INTERPROVINCIAL SECTION OF THE OTTAWA RIVER

In 1967, the provinces of Ontario and Quebec announced the terms of an administrative agreement under which the Ontario Water Resources Commission and the Quebec Water Board were to investigate the pollution of the Ottawa River. One of the terms of reference of the study included the preparation of a set of water quality standards that would define the water quality conditions which would be consistent with the many desirable uses of the Ottawa River.

The Ontario Water Resources Commission and the Quebec Water Board have agreed upon the following proposed standards as the minimum acceptable water quality that will support the present and foreseeable uses of the Ottawa River.

BASIS

The following Water Quality Standards apply to the water quality in the interprovincial section of the Ottawa River. The purposes for which these standards have been developed are:

1. to protect and maintain the existing water quality where water use has not caused water quality impairment.
2. to upgrade water quality where water use has resulted in water pollution.

The achievement and maintenance of the standards will provide protection of water quality for existing and foreseeable water uses along the interprovincial section of the Ottawa River.

RIVER MILEAGES

River mileages (R.M.) are measured upstream along the centre line of the river and/or the interprovincial boundary beginning at the confluence of the Des Prairies River with the St. Lawrence River at the east end of Montreal Island (R.M. 0.0).

ZONING OF THE RIVER

These standards recognize that the conditions of use and the related desirable water quality are not identical over the entire length of the river. Subsequently, the river is divided into zones (as discussed in 3.3) to permit the development of standards applicable to all sections of the river. The following is a description of each of the zones.

i) Zone 1 is that part of the Ottawa River lying within the Province of Quebec and extending from the confluence of the Des Prairies River with the St. Lawrence River (R.M. 0.0) to the Hydro Quebec Carillon generating station (R.M. 56.8).

ii) Zone 2 is that part of the Ottawa River extending from the Hydro Quebec Carillon generating station (R.M. 56.8) to the Chaudiere Dam at the Cities of Ottawa-Hull (R.M. 129.9).

iii) Zone 3 is that part of the Ottawa River extending from the Chaudiere Dam at the Cities of Ottawa-Hull (R.M. 129.9) to the Ontario Hydro Des Joachims generating station (R.M. 282.0).

iv) Zone 4 is that part of the Ottawa River extending from the Ontario Hydro Des Joachims generating station (R.M. 282.0) to the Canada Public Works Dam at the Town of Temiskaming (R.M. 372.4).

v) Zone 5 is that part of the Ottawa River known as Lake Timiskaming (R.M. 372.4 to R.M. 440.2) extending upstream from the Canada Public Works Dam at the Town of Temiskaming.

vi) Zone 6 is that part of the Ottawa River extending upstream from Lake Timiskaming (R.M. 440.2) and lying within the Province of Quebec.

WATER USES OF THE INTERPROVINCIAL SECTION OF THE OTTAWA RIVER (ZONES 2, 3, 4 and 5)

The water quality of the interprovincial section of the Ottawa River shall be maintained in a safe and satisfactory condition for the following uses:

- public water supply (as a source of raw water prior to conventional treatment consisting of coagulation, flocculation, sedimentation, rapid sand filtration and chlorination).
- industrial water supply including hydro-electric power generation

- agricultural water supply
- aesthetics and recreation
- fish, other aquatic life and wildlife
- waste disposal

GENERAL CONDITIONS APPLYING TO ALL ZONES IN THE INTERPROVINCIAL SECTION OF THE OTTAWA RIVER (ZONES 2, 3, 4 and 5)

- i) All wastes prior to discharge to the river must receive the best practicable treatment or control consistent with the water quality standards.

Requirements for effluents and land drainage based upon the applicable water quality standards will be established by the Ontario Water Resources Commission and the Quebec Water Board in order to maintain acceptable water quality. More stringent methods of control and/or treatment of waste inputs and land drainage may become necessary as the use of water changes or increases, or as standards are re-defined.
- ii) The responsibility for demonstrating that a waste effluent is harmless to water uses in the concentrations to be found in the receiving water, rests with those producing the discharge.
- iii) Mixing zones in the vicinity of outfalls shall be restricted as much as possible in extent to provide for the safe passage of both fish and free-floating and drift organisms.
- iv) The water quality standard which defines the acceptable concentration of a substance contained in a waste discharge will apply at the periphery of the designated mixing zone or other specified sampling locations, as determined by the Ontario Water Resources Commission and the Quebec Water Board.

WATER QUALITY STANDARDS APPLYING TO ALL ZONES IN THE INTER-PROVINCIAL SECTION OF THE OTTAWA RIVER (ZONES 2, 3, 4 and 5)

a) GENERAL STANDARDS

- i) Tainting substances - all materials that impart odour or taste to fish or edible invertebrates shall be excluded from the river at levels determined to produce tainting.
- ii) Taste - all substances that will impart an objectionable taste to the river water shall be excluded from the river.
- iii) Odour-causing materials that are not readily removable by conventional water treatment consisting of coagulation, flocculation, sedimentation, rapid sand filtration and chlorination shall not be discharged to the river.
- iv) Oil, petrochemicals or other immiscible substances that will cause visible films or toxic, noxious, or nuisance conditions shall not be discharged to the river.
- v) Nutrients from unnatural sources which will stimulate the over-production of algae, nuisance vegetation, or offensive slime growths shall not be discharged to the river.
- vi) Temperature - the normal daily and seasonal temperature variations that were present before the addition of heat due to other than natural causes shall be maintained.

Heated discharges to the river will not be permitted unless it is clearly demonstrated that heated effluents will enhance the usefulness of the water resource without endangering the production and optimum maintenance of wildlife, fish and other aquatic species. It shall be the responsibility of the user to provide evidence to support the acceptability of the discharge under these terms.

Heat may not be discharged in the vicinity of spawning areas or where increased temperature might interfere with recognized movements of spawning or migrating fish populations.

- vii) Dissolved materials may not be added to the river to increase the concentration of dissolved solids by more than one-third of the background condition of the receiving water. Allowable concentrations for dissolved

solids in each reach are presented in Sections 7 to 10 of these standards.

- viii) Settleable materials - substances shall not be added that will adversely affect the aquatic biota or will create objectionable deposits on the bottom or shore of the river.
- ix) Water uses along the Ottawa River should be controlled to prevent the degradation of existing high quality water through the significant increase in concentration of hardness, chlorides, suspended materials, turbidity and other parameters indicative of water quality degradation.

b) SPECIFIC STANDARDS

- i) pH between 6.5 and 8.3.
- ii) Total alkalinity - materials may not be added to cause the total alkalinity to go below 20 mg/l or above 50 mg/l.
- iii) Microbiology - (Microbiological standards for the Ottawa River shall be based upon requirements for body contact recreation; other uses, including raw water supply for a public water supply, are protected by these standards).

Water should be free from pathogens including any bacteria, fungi or viruses that may produce enteric disorders or eye, ear, nose, throat or skin infections.

The following geometric mean densities must not be exceeded in a series of at least 10 samples per month, including weekend samples.

- total coliforms not to exceed 1,000/100 ml.
- fecal coliforms not to exceed 100/100 ml.
- enterococcus not to exceed 20/100 ml.

- iv) Toxic substances, including pesticides, are not to be added to water in concentrations and/or combinations that are toxic or harmful to human, animal, plant or aquatic life, except where application of approved substances for the control of nuisance organisms has been authorized by the Ontario Water Resources Commission and the Quebec Water Board. The evaluation

of toxicity shall be in accordance with Section 4.1.11 "Evaluation of Toxicity".

- v) Radioactivity - The radiation dose should be the main consideration in evaluating radiological hazards to health (International Commission on Radiological Protection, 1965). If the levels of radioactivity of a water supply do not exceed those in Table 4.1.1, the water supply can as a rule be considered to be acceptable. When these limits are exceeded, the water quality may still be acceptable (as a source of drinking water) if the total intake of radioactivity does not lead to radiation doses in excess of the levels recommended by the International Commission on Radiological Protection.

TABLE 4.1.1

Radium-226 (Ra-226)	3 pCi/l
Strontium-90 (Sr-90)	10 pCi/l
Gross beta (Sr-90 and alpha emitters absent)*	1,000 pCi/l

- * Absent is taken to mean a negligibly small fraction of the above specified limits, where the limit for unidentified alpha emitters is taken as the listed limit for Ra-226.

WATER QUALITY STANDARDS APPLYING SPECIFICALLY
TO ZONE 2 OF THE OTTAWA RIVER

- i) Dissolved oxygen concentration shall be above 5.0 mg/l at all places at all times.
- ii) Dissolved solids - not to exceed 100 mg/l.
- iii) Turbidity - not to exceed 25 Jackson units.
- iv) Colour - not to exceed 40 Platinum-Cobalt units.

WATER QUALITY STANDARDS APPLYING SPECIFICALLY
TO ZONE 3 OF THE OTTAWA RIVER

- i) Dissolved oxygen concentration shall be above 6.0 mg/l at all places at all times.
- ii) Dissolved solids - not to exceed 90 mg/l.

- iii) Turbidity - not to exceed 25 Jackson units.
- iv) Colour - not to exceed 30 Platinum Cobalt units.

WATER QUALITY STANDARDS APPLYING SPECIFICALLY
TO ZONE 4 OF THE OTTAWA RIVER

- i) Dissolved oxygen concentration shall be above 5.0 mg/l at all places at all times.
- ii) Dissolved solids - not to exceed 90 mg/l.
- iii) Turbidity - not to exceed 25 Jackson units.
- iv) Colour - not to exceed 30 Platinum-Cobalt units.

WATER QUALITY STANDARDS APPLYING SPECIFICALLY
TO ZONE 5 OF THE OTTAWA RIVER

- i) Dissolved oxygen concentration shall be above 6.0 mg/l at all places at all times.
- ii) Dissolved solids - not to exceed 75 mg/l.
- iii) Turbidity - not to exceed 10 Jackson units.
- iv) Colour - not to exceed 30 Platinum-Cobalt units.

EVALUATION OF TOXICITY

Where toxic materials are being discharged, it should be assumed that the various components in the waste, regardless of the form in which they are present, may eventually be altered to the most toxic form in the aquatic environment. If a toxic substance will not evoke an avoidance response on the part of fish or other organisms, the allowable concentration of that substance in any effluent before entering the river shall not exceed the concentration normally permitted in the river at the periphery of the defined mixing zone for the effluent in question.

The evaluation of toxicity for aquatic organisms is based on use of the median tolerance limit (TLM), which is the concentration at which half the test organisms will succumb over a given period of exposure (that is 24, 48 or 96 hours). It does not, therefore, represent the safe concentration and an

application factor is applied to ensure safe condition, including allowance for sub-lethal effects.

All effluents containing foreign materials should be considered harmful and not permissible until bioassay tests have shown otherwise. The onus for demonstrating that an effluent is harmless in the concentrations to be found in the receiving waters rests with those responsible for the discharge. Information concerning acceptable bioassay procedures is available from the Ontario Water Resources Commission and the Quebec Water Board.

a) Application Factors

Concentrations of materials that are non-persistent (that is, have a half-life of less than 96 hours), or have non-cumulative effects after mixing with the receiving waters, should not exceed 1/10 of the applicable 96-hour TLM value at any time or place based on species representative of local conditions. The 24-hour average of the concentration of these materials should not exceed 1/20 of the TLM value after mixing. For other toxicants, the concentrations should not exceed 1/20 and 1/100 of the TLM value under the aforementioned conditions.

Special consideration must be given in developing application factors for some specific toxicants. These toxicants are listed in sub-section (d) - Other Toxic Substances. Application factors are subject to revision as additional bioassay information relating to the effects of toxicants on the biota is obtained.

b) Additive Effects

When two or more toxic materials that have additive effect are present at the same time in the receiving water, some reduction is necessary in the permissible concentrations as derived from bioassays on individual substances or wastes.

When toxic substances are present, the following relationship shall apply:

$$\frac{C_a}{L_a} + \frac{C_b}{L_b} + \dots + \frac{C_n}{L_n} \leq 1$$

where C_a , C_b , ---, C_n are the measured concentrations of the several toxic materials in the water and L_a , L_b , ---, L_n are the respective permissible concentration limits derived for the materials on an individual basis. Should the sum of the several

fractions (as described above) exceed one, then a total restriction on the concentration of one or more of the substances is necessary.

c) Pesticides

Insecticides, herbicides, fungicides, and rodenticides must not be present in water in concentrations that are detrimental to crops, livestock, wildlife or man.

The use of chlorinated hydrocarbon insecticides should be avoided where there is a risk of these insecticides gaining access to the river.

Safe concentrations of other pesticides and herbicides in receiving waters should be provided for through the use of application factors ranging from 1/10 to 1/100 with these values depending on the characteristic of the pesticide in question and used as specified above.

d) Other Toxic Substances

The following toxicants require special mention. As additional information becomes available, other toxicants may be added to this list or the specifications contained herein may be altered.

- ABS: The concentration of ABS should not exceed 1/7 of the 48-hour TLM at any time or place.
- LAS: The concentration of LAS should not exceed 1/7 of the 48-hour TLM at any time or place.
- ARSENIC: An application factor of 1/100 should be applied to the 96-hour TLM value as a tentative safe concentration for continuous exposure.
- AMMONIA: Permissible concentrations of ammonia should be determined by the flow-through bioassay with the pH of the test solution maintained at 8.5, DO concentrations between 4 and 5 mg/l and temperatures near the upper allowable levels.
- CADMIUM: The concentration of cadmium must not exceed 1/500 of the 96-hour TLM concentration at any time or place.
- CHROMIUM: The concentration of chromium must not exceed 1/100 of the 96-hour TLM at any time or place.

COPPER: The maximum copper (expressed as Cu) concentration at any time or place shall not be greater than $1/12$ of the 96-hour TLM value. The maximum permissible concentration for continuous exposure is between 3 per cent and 7 per cent of the 96-hour TLM.

LEAD: The concentration of lead should not exceed $1/20$ of the 96-hour TLM at any time or place and the 24-hour average should not exceed $1/100$ of the 96-hour TLM concentration after mixing.

MERCURY: Owing to demonstrated cumulative effects of mercury in fish, and the attendant hazard to people and animals, discharges of mercury to water should be avoided.

NICKEL: The concentration of nickel should not exceed $1/50$ of the 96-hour TLM concentration at any time or place.

ZINC: The concentration of zinc should not exceed $1/100$ of the 96-hour TLM concentration at any time or place.

4.2 PERMISSIBLE WASTE LOADINGS

The discharge of inadequately treated municipal and industrial wastes to the Ottawa River causes varying degrees of water quality impairment. Studies were conducted to determine the response of the aquatic environment to wastewater discharges and the potential effects of these discharges on water uses. The extent of fibre and wood chip deposition along the riverbed and the effect of these deposits on the bottom fauna and flora in the river were studied. Mathematical models were developed to predict the relationship of dissolved oxygen in the river to organic loading. The models, based upon known conditions at the time of the surveys, were adjusted to critical conditions of flow and temperature that are likely to occur in the river. The permissible loadings under these conditions were then determined and a reserve portion of the loadings set aside to provide: 1) an adequate margin of protection in recognition of the limitations of water management theory and practice; 2) the maintenance of adequate water quality in the face of population and industrial growth, urbanization and technological change. Approximately one-third of the receiving capacity of the river was maintained in reserve.

Detailed data from the studies, including methodology, are presented in Volume II of the report.

The environmental response studies have indicated that a number of specific pollution abatement programs should be undertaken immediately to ensure that the quality of the river is maintained at a level compatible with present and potential uses. All municipal, and any industrial effluents contributing to the microbiological contamination of the river (as discussed in Section 4.1) should be chlorinated before discharge to the river. In order to restore and maintain a balanced distribution of flora and fauna in all areas of the river, an effective solids removal program should be implemented at all pulp and paper mills. In addition, consideration should also be given to either eliminating losses of logs and wood debris from log drives or to finding alternative means of transporting the logs. To eliminate the pressure toward the enrichment of the river and the associated eutrophication of its natural and artificial lakes, an immediate nutrient control program should be launched. This program should include phosphorus removal at all major sources and major reduction of nitrogen from ammonia-based sulphite pulp mills. Recognizing the need for a reduction of the discharge of organic material to the river, as indicated by the mathematical models, all waste dischargers should provide adequate treatment to reduce the BOD of their effluent to the levels indicated in Table 4.2.1 and 4.2.2.

The following summation briefly outlines the proposed effluent requirements.

PARAMETER	EFFLUENT REQUIREMENT
BOD	- loadings as outlined in Tables 4.2.1 and 4.2.2.
Microbiology	- effluent disinfection
Nutrients	- phosphorus removal at significant municipal and industrial sources. - nitrogen removal at ammonia based pulping operations.
Suspended solids	- all dischargers provide treatment to remove settleable materials that will adversely affect the aquatic biota or will create objectionable deposits on the bottom or shore of the river.

Other materials including: tainting substances; taste and odour causing materials; oils and petrochemicals; dissolved materials; heated effluents; materials affecting pH, alkalinity, colour and turbidity; dissolved solids; toxic substances; and radioactive materials to be treated prior to discharge to maintain receiving water in a condition as defined in the water quality standards.

Each waste discharger should develop an acceptable pollution abatement schedule with the Ontario Water Resources Commission and the Quebec Water Board. These programs should strive for compliance with the water quality standards at the earliest possible date and in no case later than the dates outlined in the Recommendations.

4.3 ESTIMATED COSTS OF REMEDIAL MEASURES

The cost of waste management measures to correct outstanding problems and provide for the development expected along the Ottawa River is presented in this section.

Capital costs for municipal sewage treatment are based on projected populations for 1990. Projections for industrial growth are not available at this time and therefore capital costs for required industrial treatment are based on present levels of production. Allowance has been made for the existing backlog of

TABLE 4.2.1

MUNICIPAL BOD LOADING TO THE OTTAWA RIVER
(Existing* and Permissible**)

MUNICIPALITY	RIVER MILEAGE*	LOADING (lbs BOD/DAY) EXISTING** PERMISSIBLE	
Province of Quebec			
Ville Marie	421.6	410	120
Temiscaming	372.3	475	140
Chapeau	230.7	96	30
Fort Coulonge	211.4	18	90
Campbell's Bay	202.8	200	60
Shawville	178.0	50	90
Quyon	160.6	140	40
Aylmer	148.6	900	280
Des Chenes	135.4	660	90
Hull	130.0	10,000	3,100
Pte Gatineau	127.0	2,000	600
Gatineau	124.4	3,000	920
Templeton	121.1	545	160
Angers	116.0	104	30
Masson	112.5	391	120
Thurso	102.2	628	190
Papineauville	90.3	26	70
Montebello	85.3	255	80
Fasset	82.1	90	30
Grenville	68	255	80
Province of Ontario			
New Liskard	436	90	250
Bucke Township	432	0	70
Haileybury	431	40	130
Mattawa	336.3	8	50
Deep River	270.4	170	500
Chalk River	263.1	0	50
Buchanan Twp. (AECL)	263	80	50
Petawawa	251.7	540	550
Pembroke	242.0	1,800	750
Renfrew	180.8	1,200	260
Arnprior	169.5	3,000	1,800
Nepean Township	148.0	500	650
Ottawa	121.8	40,000	15,000

TABLE 4.2.1 (cont'd)

MUNICIPALITY	RIVER MILEAGE*	LOADING (lbs BOD/DAY)	
		EXISTING**	PERMISSIBLE
Cumberland	112.5	100	50
Rockland	105.7	10	60
Plantagenet	95.2	0	40
L'Orignal	73.0	0	70
Hawkesbury	68.0	1,600	460

NOTE: Permissible loadings given in this table represent the total load not to be exceeded on any given day.

Municipalities in both provinces will be required to achieve at least 70 per cent BOD reduction in their wastes through treatment prior to discharge to the river.

+ Existing loads are based upon measured or estimated quantities in waste effluent at the point of entry to the river.

++ Permissible loads are based upon the uniform reduction of pollutants in raw or untreated wastes, projected to 1991.

* River mileages (RM) are measured upstream along the center line of the river and/or the interprovincial boundary beginning at the confluence of the Des Prairies River with the St. Lawrence River at the east end of Montreal Island (RM 0.0).

** See Table 3.2.1.

TABLE 4.2.2

INDUSTRIAL BOD LOADING TO THE OTTAWA RIVER
(Existing+ and Permissible++)

INDUSTRY	LOCATION	RIVER MILEAGE*	LOADING (lbs BOD/DAY)	
			EXISTING**	PERMISSIBLE
Canadian International Paper (Kipawa)	Temiscaming	372.3	350,000	80,000
Consolidated Bathurst (Pontiac)	Portage du Fort	188.7	38,000	36,000
E. B. Eddy (Hull and Ottawa)	Hull-Ottawa	129.9	110,00	44,000
Canadian International Paper (Gatineau)	Gatineau	124.7	240,000	72,000
James MacLaren (Masson)	Masson	112.5	45,000	20,000
Thurso Pulp and Paper Co. (Thurso)	Thurso	102.2	34,000	26,000
Canadian International Paper (Hawkesbury)	Hawkesbury	68.0	230,000	50,000
Canada Packers	Hull	127.9	8,500	2,400
Canada Veneers Ltd.	Pembroke	242.3	120	35
Union Carbide of Canada	Arnprior	169.5	670	15
Quyon Farmers Co-op	Quyon	160.6	60	20
Hanson Mills Ltd.	Hull	130	120	35
Co-operative Agricole de Papineau	Papineauville	95.2	770	230
Hand Chemical Company	Papineauville	90.3	20	10
Papineauville Lumber Co.	Papineauville	90.3	40	10
Montebello Metal Ltd.	Montebello	85.3	10	5
Arnold Farms Ltd.	Grenville	68.0	20	5
Scierie Georges Dansereau & Sons Ltd.	Grenville	68.0	10	5

TOTALS

NOTE: Permissible loadings given in this table represent the total load not to be exceeded on any given day. Industries may chose to direct their wastes to municipal facilities for treatment. Any individual allocation or portion thereof which would no longer be required because of a lowering of, or a change in production will be returned to the reserve already set aside.

TABLE 4.2.2 (cont'd)

+ Existing loads are based upon measured or estimated quantities in waste effluent at the point of entry to the river.

++ Permissible loads are based upon the necessary reduction of existing waste loads to the river in order to ensure the maintenance of adequate water quality.

* River mileages (RM) are measured upstream along the center line of the river and/or the interprovincial boundary beginning at the confluence of the Des Prairies River with the St. Lawrence River at the east end of Montreal Island (RM 0.0).

** See Table 3.2.2 (Pulp and paper mill loadings have been averaged for this table).

needed municipal work, including sewer extensions. However, land acquisition and financing costs have not been included. These estimates provide for the implementation of phosphorus removal which will be required at some of the major municipal and industrial discharges.

The cost of constructing municipal waste treatment plants and sewers to meet the needs of 1990 is estimated at \$25 to 30 million for municipalities on the Ontario side and \$20 to 25 million for municipalities on the Quebec side of the river. Detailed costs for specific municipalities will depend on such factors as size and location of the municipality, soil conditions, land availability and waste characteristics. Although not included in these estimates, costs of maintenance and operation will be significant, possibly in the range of one million dollars per year and can be expected to increase from year to year.

The capital costs for industrial waste control to correct the existing backlog of needed treatment are estimated to be \$30-35 million for Quebec and \$10-15 million for Ontario. Practically all of the industrial costs will have to be borne by the pulp and paper industry. Their portion of the costs will be in the order of \$5-10 per ton of production (including maintenance, operation and capital costs).

The reported costs for municipal and industrial treatment apply only to those discharges directly affecting the quality of the Ottawa River.

To summarize, the total capital costs for remedial measures on the Ottawa River are estimated to be \$90 to \$110 million.

4.4 CYCLES OF WATER QUALITY CONTROL

A cycle of water quality control can be defined as the period of time required:

to analyze problems existing in a drainage basin; to establish a basis for treatment or controls to correct the problems; to design and build required facilities; to operate facilities and thereby utilize an appropriate proportion of the receiving capacity of the watercourse in keeping with the water quality standards for the watercourse.

The present cycle of water quality control commenced in 1967 when Ontario and Quebec agreed to undertake the Ottawa River study in order to determine what pollution pressures exist along the main stem of the Ottawa River. The water quality standards and acceptable waste loadings presented in this report formulate the basis for the development of treatment or controls to correct the problems. The remainder of the present cycle of water quality control will see the design and construction of the required facilities and the operation of these facilities for a period of time. It is anticipated that this cycle will require a total of 20 years for completion. Another cycle of water quality control should be commenced in the late 1980's or at a time when urban and industrial growth have reduced the initial reserve of approximately one-third of the receiving capacity of the stream to 10 to 20 per cent. At that point in time, a major water quality study of the Ottawa River should be undertaken to re-assess the conditions of the river in view of anticipated developing pollution pressures. This study would re-assess the permissible loading rates granted to each waste discharger.

In the interim period, no user would be granted permission to discharge more than his permissible load to the river, until such a time as he had installed and had operational a treatment plant capable of the highest practicable degree of treatment consistent with current technology. When this is achieved and a need for further growth demonstrated, the user could then apply to the Ontario Water Resources Commission and the Quebec Water Board for permission to increase the quantity of wastes discharged.

It is recognized that water quality considerations must become an integral part of future overall planning of land and water use. In order to restore water quality and maintain it at a level acceptable for the greatest number of uses, a reasoned approach to the use of the river will be required by the water users in the two provinces. It may ultimately become necessary to encourage some uses of the river over others as a result of

economic or social pressures. If the restoration and preservation of the river is to be maintained as a primary objective, it may ultimately become necessary to limit the locations available for industrial development. Relocation of existing industries may become desirable where the necessary measures required to control pollution are not feasible for certain industrial activities.

For future cycles of water quality control in the Ottawa River, it may become necessary to consider several alternatives for the preservation of adequate water quality. However, at the present stage of development in the basin, recognizing the lack of adequate water pollution control in the past, it is technically feasible and economically justifiable to complete the present cycle of water quality control by satisfying reasonable standards of water quality without extensive consideration of numerous alternatives.

CHAPTER 5

ADDITIONAL STUDIES REQUIRED

In the case of the Ottawa River, the opportunity exists to study, in depth, efforts to preserve a major water resource. The changes in water quality as anti-pollution programs are implemented must be carefully documented. This will provide a basis for rationally evaluating the expected benefits in relation to the cost of future water quality programs. As the country continues to develop, greater pressures will be placed on all water resources and the cost of maintaining the quality of all waters at desirable levels for all uses will, even if attainable, require such a large commitment of our economic resources that it may no longer be justifiable solely on the basis of pollution control.

A number of additional studies are necessary to provide the required background information to monitor the degree of success of the remedial programs that must be undertaken to alleviate the existing pollution pressures on the Ottawa River. Specific studies are necessary to provide accurate engineering data to be used in the design of treatment facilities, and for determining the best solution for remedying water quality problems resulting from bottom deposits of sludge containing wood fibre and mercury. At some point in time, it will be necessary to assess the effect of waste treatment programs on the river and determine whether or not new limits should be placed on the wastes being discharged by the water users. The following studies should also be undertaken.

5.1 SURVEILLANCE AND MONITORING

To ensure that the water quality of the river is maintained at a suitable level to support the various desirable water uses including public and industrial water supply, recreation, agriculture, electric power generation, transportation and waste disposal, it will be necessary to maintain a water quality monitoring program. Since 1967, a program of water quality monitoring has been carried out on a routine basis throughout the 335 mile stretch of the Ottawa River between the dam at Temiscaming and the Oka Ferry. All major tributaries to the Ottawa River have also been sampled. This program has provided data which has been of value in assessing the overall health of the river.

This surveillance program should continue in order to assess the response of the river to implementation of the recommended remedial measures. Under the present monitoring program, samples are collected on a monthly basis at 31 locations on the Ottawa River and 29 locations on tributaries to the river. The parameters measured have been selected in context with the specific water uses of the area. Under the present program, all samples are analyzed for coliform bacteria, water temperature, dissolved oxygen, 5-day biochemical oxygen demand, total and suspended solids, turbidity, conductivity, total and soluble phosphorus, free ammonia, total kjeldahl, nitrite, nitrate, chlorides, hardness, alkalinity, total iron and pH. At some locations, samples are also analyzed for the following parameters: anionic detergent, total arsenic, chemical oxygen demand, total chromium, total copper, cyanide, total fluoride, sulphate, total nickel, total lead and total zinc.

Continuous recording water quality meters are maintained by the Ontario Water Resources Commission at the Otto Holden and Carillon generating stations. Records of dissolved oxygen temperature, pH and conductivity are available from the meters. Consideration should be given to coupling these meters into a telex network to make the data immediately available for better water quality management.

Since 1966, water samples have been taken for radiological analyses at 9 stations in the Rolphton and Chalk River areas. These samples are collected monthly as part of the routine water quality monitoring program and are analyzed for gross alpha, gross beta and dissolved solids.

In addition to routine monthly monitoring, there is a need for biological surveillance programs. Long term biological studies should be initiated whereby the effects of settleable materials, nutrients and toxic and cumulative substances are assessed at routine intervals.

A monitoring program of this nature should be continued along the Ottawa River to provide a long term assessment of the quality of the river and to detect any water quality degradation at an early stage.

5.2 RESTORATION OF THE RIVER

The recommended reduction of chemical and solid waste loadings will do much to restore the quality of water in the Ottawa River. It will do little, however, to eliminate existing deposits of mercury; wood fibre, chips and bark; and logs that

cover much of the river bed. Specific programs must be designed to determine the magnitude of each problem and to initiate the remedial measures necessary if the complete restoration of the river is to be achieved.

Mercury Deposits

Until recently, phenyl mercuric acetate was used as a slimicide at the pulp and paper mills of the E. B. Eddy Company at Hull and the Canadian International Paper Company at Gatineau. The resultant mercury losses to the river have accumulated in sediments and in turn have contaminated fish taken from the area. Studies should be undertaken to determine in greater detail the extent and degree of contamination of bottom deposits and to identify the form(s) in which mercury is present in the river. A decision could then be taken as to the remedial action that might be undertaken to eliminate the contamination and restore the fishery.

Solid Waste Deposits

Suspended solids, primarily wood fibre, bark and wood chips constitute a major portion of the wastes discharged from the pulp and paper mills on the Ottawa River. Waste treatment will eliminate much of this solid material in the future. However, existing deposits of slowly decaying materials will remain in the river for many years to come. Removal of this material may be necessary to eliminate some of the local problems caused by existing sludge deposits. However, removal of the deposits is likely to be very expensive, and subsequently detailed studies of this problem should be considered to assess the practicability and need of such a program.

Log Driving

The use of the river for the transportation of logs interferes with other river uses. Alternative methods of log transportation have been developed and should be investigated for possible use in the Ottawa River basin.

Alternative methods include the use of barges to carry logs. However, the cost of constructing structures to by-pass the power dams would be excessive, possibly making this an unacceptable alternative. Transportation of logs over land by truck or rail is probably a reasonable alternative. This method of transportation offers the advantage of year-round delivery of logs thus eliminating stockpiling. Studies by the railway industry indicate that rail transportation of logs is more economical in the long run than transportation by river. In the interest of establishing the best possible multiple use balance

in the basin, a study should be made of the alternatives to log driving. The study should, in addition to considering the cost of the log transportation, also consider the damage arising from log driving. The study could investigate alternatives such as locating chippers adjacent to cutting areas for pulpwood and transporting chips instead of logs.

GLOSSARY OF TERMS

ABS	sodium alkyl benzene sulphonate
algae	primitive photosynthetic plants, many microscopic, occurring suspended in water (phytoplankton) or attached to rocks and other substrates
anaerobic	refers to organisms which either by obligation or facultatively thrive in the absence of oxygen
assimilation	the transformation of absorbed nutrient substances into body substances
asu/ml	an areal measure of concentration. One areal standard unit is equivalent to 400 square microns
benthic	refers to the benthic region or bottom of all waters
bioassay	a determination of the concentration of a given material necessary to affect a test organism under specified conditions
biomass	the total mass or weight of all organisms in a specified area
biota	all living organisms of a region
BOD	biological (or biochemical) oxygen demand. The amount of oxygen, in milligrams per litre, required by organisms and for the aerobic biochemical decomposition of organic matter present in water. BOD ₅ is the biochemical oxygen demand over a period of five days.

cfs	cubic feet per second. A measure of flow
COD	chemical oxygen demand. The total oxygen consumed by the chemical oxidation of material in water
Curie	a unit of radioactivity. It is the quantity of radium emanation in equilibrium with one gram of radium.
- microcurie	one millionth of a curie
- picocurie	one millionth of a microcurie
- pCi/l	picocuries per litre
coliform bacteria	A group of bacteria common in fecal wastes, but also including forms associated with plants and grains
confluence	a junction or flowing together of streams; the point where streams meet
detritus	finely divided settleable material. Organic detritus consists of the broken-down remains of animals and plants; inorganic detritus refers to settleable mineral materials
dissolved oxygen sag	the profile of dissolved oxygen content along the course of a stream, resulting from deoxygenation associated with biochemical oxidation of organic matter and reoxygenation through the absorption of atmospheric oxygen and through photosynthesis
DO	dissolved oxygen
effluent requirements	numerical or verbal descriptions of the quality of a waste or drainage effluent at the point of discharge to a receiving water body, land disposal site or waste disposal well
enterococci	a group of spherical bacterium or cocci having its normal habitat in the intestines of man or animals

eutrophication	The process of progressively increasing enrichment in supply of plant nutrients. The term refers to the whole complex of changes to a body of water which accompanies increasing enrichment with plant nutrients.
fault	A break in the continuity of rock strata
fauna	The animals of a given region or period considered as a whole
flora	The plants of a given region or period considered as a whole
freshet	Small affluent streams which have a high rate of flow during the spring season and often carry a heavy silt load during their peak flow
glancing booms	secured collection of floating logs on a river which guide a log drive
headwater	the upper reaches of a stream near its source; the region where ground waters emerge to form a surface stream
land drainage	water that has drained from the land surface naturally or through man-made drainage systems
LAS	linear alkylate sulphonate
mgd	millions of gallons per day
mg.eg./l	milligram equivalents per litre; a unit indicating the chemical equivalence of ions; derived by dividing the concentration of an ion in milligrams per litre by the combining weight of that ion. Note: combining weight = $\frac{\text{atomic or molecular weight of an ion}}{\text{ionic charge}}$
mg/km	milligrams per kilogram
mg/l	milligrams per litre

midges	a tiny insect of the family Chironomidae. Midges commonly spend the greater part of their life in the larval stage living on the bottom of lakes or streams. Bloodworms are the larvae of one important group of midges
oligotrophic	refers to waters with a small supply of nutrients and hence a small organic production, usually having abundant dissolved oxygen at all depths
pathogenic bacteria	bacteria which cause disease
permeability	the property of a material that permits appreciable movement of water through it when it is saturated and the movement is actuated by hydrostatic pressure of the magnitude normally encountered in natural sub-surface water. Perviousness is sometimes used in the same sense as permeability.
plankton	the assemblage of micro-organisms, both plant (phytoplankton) and animal (zooplankton) which live (floating, drifting or swimming) in the open water region of lakes and rivers
plate count	the number of colonies of bacteria grown on selected solid media at a given temperature and incubation period, usually expressed in number of bacteria per millilitre of sample
ppm	parts per million. A measure of concentration
primary treatment	the first major treatment in a wastewater treatment works, usually sedimentation
raw water	surface or ground water, prior to treatment
reaeration	the absorption of oxygen into water under conditions of oxygen deficit

R.M.	river mileage. Measured here upstream along the centre line of the river and/or the Quebec/Ontario boundary beginning at the confluence of the Des Prairies River with the St. Lawrence River at the east end of Montreal Island
Secchi disc	a white and black disc, 20 cm in diameter, that is employed to determine the transparency of a body of water in situ
secondary treatment	the treatment of wastewater by biological methods after primary treatment by sedimentation
spillway	a waterway in or about a dam or other hydraulic structure, for the escape of excess water
sulphate reducers	bacteria capable of utilizing oxygen from sulphate compounds, thereby reducing them to sulphides
surface waters	water, including lakes and streams, lying on the surface of the land in contrast to underground water
taxa	plural of taxon: any unit of classification of living things
thermal stratification	the formation of layers of different temperatures in bodies of water
thermocline	the layer in a body of water having a temperature gradient equal to or exceeding one degree centigrade per meter of depth
TLm	median tolerance limit. The concentration of a given material or toxicant at which 50 per cent of the test organisms are able to survive for a specified period of exposure

TON	the number of times an odour bearing water must be diluted to obtain a concentration at which the odour is barely perceptible
waste	liquid carrying unwanted materials or compounds resulting from human activities or enterprises
water quality criteria	numerical or verbal descriptions of the water quality required for particular uses
water quality standards	Numerical or verbal descriptions of the water required for a variety of uses in a given drainage
weir	<ul style="list-style-type: none"> (1) a diversion dam (2) a device that has a crest and some side containment of known geometric shape such as a V, trapezoid or rectangle, and is used to measure flow of liquid. The liquid surface is exposed to the atmosphere

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The Ontario Hydro and Hydro Quebec provided flow data upon request, assisted in the evaluation of drought flows expected to occur within the basin and provided operational information of value in preparing for tests along various reaches of the river. When necessary, the power authorities regulated flows in the river in order that special surveys could be conducted; their participation involved a significant number of man hours for technical and engineering staff as well as some monetary costs due to lost power production.

The Ontario and Quebec Departments of Lands and Forests, the Quebec Department of Tourism, Hunting and Fishing, and the Quebec Department of Natural Resources provided information describing the forestry, recreational and fishery potential of the basin. The information included creel counts,

cottage counts, and insecticide usage. Aerial photographs of the Ottawa River were provided by the Quebec Department of Lands and Forests.

Both the Ontario and Quebec Departments of Health assisted in providing information from Medical Officers of Health describing bacterial contamination at bathing areas along the river. This information was helpful in modifying surveillance programs to improve coverage of problem areas.

The Ontario and Quebec Departments of Municipal Affairs provided information on population projections, socio-economic information for the capital area, and other urban areas within the basin.

The Provincial Departments of Highways assisted with information relating to proposed highway developments.

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The Canadian Hydrographic Service supplied complete sets of river bottom contour maps. Information concerning developments proposed by the National Capital Commission including other supporting documents were generously provided by the Commission.

The population and agricultural census of the Dominion Bureau of Statistics was employed in the development of future population projections.

A joint federal-provincial study, the Rideau-Trent-Severn Study, which investigated the recreational potential of the Rideau and Trent-Severn waterways, has been of value as a source of information.

Municipalities supplied information relating to uses of the river including recreation, water supply and wastewater disposal. The regional municipality of Ottawa-Carleton assisted by supplying information contained in the Central Area Study of 1969. In addition, the Ottawa Waterworks Department provided physical equipment and working space for the survey crews.

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university. The Canadian Forces Base, Rockcliffe Park and the Britannia Yacht Club were utilized as centres of survey operations.

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Numerous staff members of the Ontario Water Resources Commission and the Quebec Water Board contributed to the data collection, analysis and preparation of the report.

APPENDICES

APPENDIX A

SUMMARY OF FINDINGS FROM PREVIOUS OTTAWA RIVER POLLUTION SURVEYS

Investigations of pollution in the Ottawa River over the past 20 years have been of value in the planning and development of the present Ontario-Quebec water quality studies. The most thorough water quality investigations previously undertaken on the Ottawa River include reports prepared by Dr. Lucien Piche (1954), the Ontario Department of Health (1956), and the Quebec Water Board (1966). These reports were consistent in their findings on pollution throughout the waterway.

The report prepared by Dr. Piche indicated gross organic pollution and aesthetic impairment of sections of the river downstream from Ottawa and Hawkesbury. Dr. Piche reported that sections of the river downstream from the Hawkesbury mill of the Canadian International Paper Company were almost void of dissolved oxygen.

The report of the Ontario Department of Health concluded that significant water quality degradation occurred in the Timiskaming area where the townsites of Thorne and Temiskaming, and the Kipawa pulp mill of the Canadian International Paper Company all discharged raw wastes to the Ottawa River. At Mattawa, primary sewage effluent was discharged to the Ottawa River via the Mattawa River. At Pembroke, Renfrew, Arnprior and Carleton Place raw sewage was discharged to the Ottawa River via the Indian and Muskrat, the Bonnechere, the Madawaska and the Mississippi rivers respectively. In addition, wastewater from a woolen mill was discharged to the Mississippi River at Carleton Place. The report, in describing the Ottawa area, stressed the aesthetic degradation of the river in the area immediately adjacent to the parliament buildings in Ottawa.

The 1966 report of the Quebec Water Board presented data describing the treatment of wastes being discharged to the Ottawa River from various sources in Quebec. It estimated that approximately 7.5 per cent of the domestic wastes received treatment, and only 0.5 per cent of the entire waste load, including that contributed by the pulp and paper mills, received treatment prior to discharge to the river.

All three reports described the same major pollution sources in the Ottawa-Hull Carillon-Pointe Fortune section of the river. Commencing from Ottawa-Hull, these sources were as follows:

1. E. B. Eddy (Hull and Ottawa) discharged untreated wastes from the production of some 470 tons of paper products per day.
2. The raw sewage from the Ottawa district, including Eastview (now Vanier), Rockcliffe, Hull, South Hull and Gatineau, (total population 350,000) was discharged to the Ottawa River.
3. The wastes from the Canadian International Paper Company Gatineau mill operation producing approximately 900 tons of newsprint and 250 tons of dissolving cellulose per day, were discharged to the Ottawa River, north of Kettle Island.
4. The Lievre River, within its last 4 miles, was collecting the raw sewage from the Town of Buckingham (population 6,500), the chemical wastes from the Electric Reduction Company at Buckingham, the raw sewage from the Town of Masson (population 2,300), and the untreated waste discharges from the James MacLaren Company pulp and paper mill which was producing approximately 385 tons of newsprint per day. This entire load was discharged to the Ottawa River via the Lievre River.
5. Raw sewage from the Town of Hawkesbury (population 8,000), and the wastes from the Canadian International Paper Company Hawkesbury mill operation which was producing approximately 210 tons per day dissolving pulp were being discharged to the Ottawa River at Hawkesbury.

APPENDIX B

PHYSIOGRAPHY (1)

1. General Characteristics

The Ottawa River is the largest tributary of the St. Lawrence River. Its drainage area extends between 73°34' and 48°42' latitude north. The watershed is bounded on the north by the drainage basins of four rivers flowing to James Bay (Mattagami, Abitibi, Harricana and Nottaway rivers) and on the northeast and east by the St. Maurice River basin. The southeastern and southern contiguous basins are drained by a series of small tributaries of the St. Lawrence River and those of the southwest by tributaries of Lake Ontario, principally the Trent River system. Georgian Bay receives runoff from the western neighbouring watersheds of which the French River basin is the most important.

The total drainage area of the Ottawa River basin at its outlets from the Lake of Two Mountains is 56,000 sq. mi. (35,600 sq. mi. in Quebec and 20,900 sq. mi. in Ontario) representing approximately 11.2 per cent of the total drainage area of the St. Lawrence River basin (507,700 sq. mi.). This drainage area is exceeded by only a few Canadian rivers, namely: the Mackenzie River (696,700 sq. mi.) and some of its tributaries (Peace, Liard, and Athabasca rivers); the Nelson River (414,00 sq. mi.) and its tributary, the Saskatchewan River (159,900 sq. mi.); and by the Fraser River (89,600 sq. mi.). It is the largest all-Canadian river in the eastern part of the country.

2. Topography

The present topography of the Ottawa River basin is mainly the result of glaciation upon two mountain formations, the Laurentians on the right side of the river (facing upstream), and the Algonquin dome on the left side. A series of lowlands are present which were previously covered by water for various periods, the most important being the area formerly occupied by the Champlain Sea. When the final glacier of the Ice Age retreated, it left behind abraded mountains and elevated lowlands scattered with lakes and swamps. Large portions of the basin were covered by glacial drift, while part of the higher land abraded by the glaciers remained as bare rock. The pattern of the drainage channels followed the pattern of ice flow and most of the resulting river beds consist of a series of glacial lakes connected by waterfalls. A series of faults affecting the Champlain plain partly remolded this lowland.

- (1) Information used in compiling the physiography was obtained from the following sources:
(Canada Department of Northern Affairs, 1962), and
(Ottawa River Engineering Board, 1965).

3. Drainage Channels

The Ottawa River rises in Lake Capimitchigama, in the northeastern portion of the basin, and pursues a westward course to the head of Lake Timiskaming. From this point, it follows a general southeasterly direction to the City of Ottawa and thence an easterly direction to enter the St. Lawrence River at the Island of Montreal. The total length of the Ottawa River is approximately 720 miles and the total descent is 1,200 feet, producing an average slope of 1.69 ft./mi. Of this drop, 350 feet occurs in the 260 miles above Lake Quinze-Simard, a slope of 1.35 ft./mi.; 275 feet occurs between Lake Quinze-Simard and Lake Timiskaming, along a stretch of approximately 14 miles, a slope of 19.70 ft./mi.; and the remaining 575 feet occurs along the lower 456 mile portion of the river, a slope of 1.24 ft./mi.

Like many other rivers in glaciated regions, the Ottawa River consists of a chain of lakes connected by sections of rapids and waterfalls. The lakes in the upper portion of the basin are larger (Lake Dozois, Grand Lake Victoria, Lake Simard, Lake Des Quinze and Lake Timiskaming) than those located downstream along the interprovincial boundary. Between Timiskaming and Ottawa, there are a series of smaller lakelike expansions (Allumette Lake, Lower Allumette Lake, Coulonge Lake, Lake Rocher Fendu, Lake Des Chats and Lake Deschenes). Below the City of Ottawa, lakes and rapids are fewer but in the final reach the Long Sault Rapids and Carillon Rapids, now flooded by the Carillon power development, account for the majority of the descent of the river from L'Orignal Bay to the Lake of Two Mountains. Here, the waters of the Ottawa River find their way to the St. Lawrence River by means of four outlets: the Vaudreuil and Ste. Anne De Bellevue channels which empty into Lake St. Louis, and the Des Prairies and Des Mille Iles rivers which flow to the north of Montreal Island before joining the St. Lawrence River.

Most of the rapids along the Ottawa River have been developed for power generation with the corresponding lakes and lakelike expansions being utilized for storage.

From the headwaters of Lake Timiskaming downstream, the Ottawa River has 26 tributary rivers of significant size. Fourteen of these tributaries enter the Ottawa from the left bank and include the Montreal and Madawaska rivers on which Ontario Hydro has developed hydro-electric generating stations and the Rideau River which forms part of the Rideau Canal system. Right bank tributaries include the Coulonge, the Gatineau and the Du Lievre rivers; all three being used for log driving. The latter two rivers supply nearly one-third of the water in the Ottawa River system in addition to supporting several power

developments. The tributaries to the Ottawa River are listed below in Table B-1. A physiographic description of each tributary follows in Section 3.1 Tributaries.

TABLE B-1

TRIBUTARIES TO THE OTTAWA RIVER

Left Bank Tributaries

Blanche River
Montreal River
Matabitchuan River
Jocko River
Mattawa River
Petawawa River
Indian and Muskrat rivers
Bonnechere River
Madawaska River
Mississippi River
Rideau River
South Nation River
Rigaud River
Raquette River

Right Bank Tributaries

Kipawa River and Gordons
Creek
Dumoine River
Schyan River
Noire River
Coulouge River
Quyon River
Gatineau River
Du Lievre River
Blanche River
Petite-Nation River
Rouge River
Du Nord River

3.1 Tributaries

a) Left bank tributaries

The slopes, average elevations and the precipitation and runoff of these tributaries are in most cases smaller than those found on the right bank. However, there is a large variability in the characteristics of the basins from the rocky northern tributaries to the flat South Nation River basin.

The Blanche River is the most northerly left bank tributary having its confluence with the interprovincial section of the Ottawa River. The majority of the basin is located within Ontario with only the eastern extremities of the watershed in Quebec. The river enters the Ottawa River at the northern end of Lake Timiskaming.

The Montreal River which flows in a southeasterly direction from a point near the Town of Matachewan (where two tributaries of almost equal importance, the West Montreal and East Montreal rivers, combine) to the point at which it has its confluence with the Ottawa River midway along the western shore

of Lake Timiskaming. The narrow valley of the river runs parallel to the eastern boundary of the watershed, close to the limit of the Englehart lowland. The river has a low gradient with the exception of the lower portion which is marked by rapids and waterfalls. The larger tributaries are Sydney Creek and the Bear and Lady Evelyn rivers. These streams have much steeper slopes than the main stem. Variable permeability conditions and low precipitation caused by the sheltering nature of the topography of the upper portion of the basin results in lower than average runoff. This trend continues throughout the southern part of the basin where elevations and slopes increase.

The Matabichuan River enters Lake Timiskaming just downstream from the mouth of the Montreal River. The river rises in Mountain Lake at an elevation of about 1,200 feet. It flows first in a southeasterly and then in a northerly direction, descending 620 feet in 39 miles. This tributary has less than average runoff as a result of below average precipitation.

The Jocko River is a small tributary flowing in a southeasterly direction which enters the Ottawa River halfway between the Timiskaming dam and the Otto Holden generating station. It has a smaller slope than the Matabichaun River.

The Mattawa River rises in Trout Lake, at an elevation slightly above 900 feet and enters the Ottawa River about 5 miles downstream from the Otto Holden generating station, at an elevation of about 500 feet. The main tributary, the Amable Du Fond River, flows from the south, draining slightly less than half of the watershed. Low elevation and slopes, and slightly below average precipitation results in a low yield from this basin.

The Petawawa River rises in Otterslide Lake in Algonquin Park at an elevation of about 1,400 feet, has a total length of approximately 130 miles, and enters the Ottawa River in Allumette Lake at the 365-foot elevation. From its headwaters, the river flows in a northeasterly direction for 30 miles through a series of five lakes before it turns in an easterly direction. Its tributaries consist of Little Nipissing, Little Madawaska, White Partridge and the Barron rivers. All of these rivers rise in the Algonquin dome. The upper portion of the basin has low permeability and above average precipitation. The lower portion of the watershed is more pervious and has less precipitation which results in significantly less runoff.

Two small tributaries, the Indian River and the Muskrat River, converge near Pembroke to make a single entrance into the Ottawa. The Indian River issues from the fault zone uplands by way of the deep valley of the Gardez pied fault. The Muskrat

River is aligned with a fault of the same name. The river flows through a series of lakes. One of these, the Muskrat Lake, is about 10 miles long and extremely deep. All of these lakes are in a lowered fault block and associated with limestone outliers.

The Bonnechere River rises on the eastern slope of the Algonquin dome from several relatively small lakes, at a level slightly above 1,000 feet. It takes a generally east-southeasterly course, draining a series of small and large lakes (Golden Lake, Round Lake, and Clear Lake) and joins the Ottawa River near Castleford in the Lake Des Chats (elevation 243 feet). The course of the stream is almost entirely controlled by the faulted block relief of the area. The valley of the river is only slightly entrenched and drift barriers cause expansion into broad lakes. Below Eganville, the valley deepens in the limestone preserved in the floor of the Bonnechere Graben, and further downstream, in clay. Low elevations, slopes, precipitation, and variable permeability (possibly some leakage through the limestone) are primarily responsible for the much below average runoff of 9.3 inches, which is the lowest in the entire Ottawa River basin.

The Madawaska River is the largest and longest left bank tributary of the Ottawa River, its total length exceeding 200 miles. The source of the river is in a series of lakes (Cache, Whitefish and Rock) in the Algonquin dome at an elevation of approximately 1,300 feet. In its upper reaches, the river flows in a southeasterly direction draining a series of lakes, the most important of which are Bark and Kamaniskeg lakes. It then turns in a northeasterly direction and falls to the Ottawa River at Arnprior (elevation 243 feet). Its most important tributary is the York River entering from the south at a point downstream from Kamaniskeg Lake. The upper Madawaska flows within the Algonquin dome through a series of scenic gorges. Its lower reach is deeply entrenched in a clay portion of the Champlain plain. Although the upper part of the basin is within the Algonquin dome and has high elevations and steep slopes the runoff is less than average, due to below average precipitation.

The Mississippi River rises in Mazinaw Lake (elevation 875 feet) which lies at the southeast periphery of the Algonquin dome. It flows in a northeasterly direction, turns to the north at Carleton Place and enters the Lake Des Chats (elevation 243 feet) a few miles downstream from Arnprior. Only the uppermost part of the river is within the Algonquin dome, while the rest of the basin extends across the Champlain plain. The watershed has lower elevations and smaller slopes than the neighbouring Madawaska basin, but a slightly higher precipitation maintains the runoff at a level close to that of the Madawaska.

The Rideau River has its headwaters in Burrige Lake at approximately 500 feet above sea level. The river flows in a northeasterly direction, through Rideau Lake, and bends to the north near Osgoode Station. It then enters the Ottawa River at the City of Ottawa, after falling over a ledge of limestone.

The most important tributary is the Tay River which drains a number of lakes. The uppermost portion of the Rideau River basin, including the Tay River, lies in a sedimentary and metamorphic pre-Cambrian prolongation of the Algonquin dome. The middle and lower portion extends into the Champlain plain, consisting mainly of clay and some sand. The gentle slopes of the clay plains result in swamps which yield little runoff. Evaporation is, therefore, high and in spite of the average precipitation, the runoff is below average.

The flat slope of the Rideau provided favourable conditions for a navigation system which was completed in 1832 by Colonel John By.

The South Nation River is peculiar in that its features are the result of postglacial influences, its geomorphic features all postdating the retreat of the Champlain Sea. It rises northwest of Brockville at an elevation of approximately 400 feet, flows in a general northeast direction for most of its course, then turns in a northwest direction for only a few miles before entering the Ottawa River at a point 20 miles downstream from Rockland. One hundred feet of its total descent occurs in the first 7 miles and another 75 feet in the next 23 miles, so that the actual slope of the river for most of its course is very small. The slope is close to zero in the lower reaches, where the river flows along an old Ottawa River estuary corresponding to an intermediary phase of the Champlain Sea. The river has a relatively large number of tributaries, the principal ones being Bear Brook and Castor River which drain very flat land. Since most of the basin is covered by plains of clay or sand, there are within its boundaries important areas which do not contribute flow to the river. Their runoff is collected by peat bogs (Alfred, Mer Bleue, Winchester, Moose Creek and others). The runoff for this river is not as low as the Rideau River, since it receives more precipitation. Most of the runoff occurs during the spring flood. Ice jams have a tendency to occur frequently due to the northerly flow.

The series of left bank tributaries is completed by the Rigaud and Raquette rivers, two small tributaries that have their confluence with the Ottawa River within the Province of Quebec.

b) Right bank tributaries

These tributaries have in common the following features: high elevations; steep slopes; a southerly direction of the main stem (probably related to the process of glacier advance, flow and retreat). They also have highly glaciated topography, low to very low permeability and close to or higher than average precipitation and runoff. Because they flow from north to south, the concentration of flow in spring is reduced to some extent. The occurrence of ice jams is infrequent.

The entire right bank drainage area from the headwaters to Lake Timiskaming has no important tributaries, the flow being collected directly by the chain of lakes which form the upper Ottawa River. Even the Kipawa River is a system of lakes situated 300 feet higher in elevation than the main stem. These lakes collect the runoff inside the large bow of the Ottawa between Lake Simard and Lake Timiskaming. This system has two outlets; the Kipawa River, which flows into Lake Timiskaming and Gordon Creek which enters the Ottawa River just below the Timiskaming dam. The natural discharge of Gordon Creek was only about one-eighth of the total discharge of the lake, but its capacity was increased to supply a power development. Elevations and slopes are close to the average values, but greater than average precipitation and low permeability produce considerable runoff.

The Dumoine River is the first of eight major tributaries which drain from the north into the Ottawa River. It rises in Lac aux Ecorces at an elevation of about 1,200 feet, and drains a series of large lakes, the most important being Dumoine Lake. Flowing mainly in a southerly direction through a series of rapids and falls, the Dumoine River joins the Ottawa River in a forebay of the Des Joachims power plant at an elevation of 500 feet. Its most important tributary is the Riviere de L'Orignal, which drains a series of lakes close to the Grand Lake Victoria system before flowing into Dumoine Lake from the north. The Dumoine River basin extends into the Laurentian Hills.

A series of small tributaries with no hydrologic records separates the lower Dumoine from the lower Noire River. Among these, the largest is the Schyan River.

The Noire River rises in a chain of small lakes at an elevation of about 1,350 feet and flows to the south-southeast through a series of rapids and falls. Many large lakes lie within the basin, including the Moose, St. Patrick and McGillivray lakes, however, none of them are on the main stem of

the river. Natural conditions are similar to the Dumoine basin, resulting in average runoff.

The Coulonge River has its headwaters, like the Dumoine River, in a chain of lakes close to the upper Ottawa system of lakes at an elevation of about 1,350 feet. It flows in a south-southeast direction, parallel to the Noire River, through a series of rapids, falls and stillwaters, but no important lakes. It enters the Ottawa River near Fort Coulonge at an elevation of approximately 344 feet. The Coulonge River has two important tributaries: the Corneille River draining a chain of lakes in the upper reaches and East Coulonge River, flowing parallel to the middle course of the main stem. The basin consists of rough mountains and hills in the upper portion, while the lower portion consists of small rolling hills. The lower portion of the basin has a higher permeability than the upper portion. The above average runoff in the headwaters decreases in the downstream areas.

The Quyon River is a small tributary separating the lower Coulonge and Gatineau river basins. Rising at an elevation of about 1,250 feet, it flows for a few miles in a westerly direction and then turns toward the south-southeast to enter the Ottawa near Quyon at an elevation of approximately 190 feet.

The Gatineau River is by far the most important tributary of the Ottawa River. Its headwaters consist of a series of tributaries rising in the Laurentian mountains close to the headwaters of the Ottawa River at an elevation of about 1,350 feet. After being joined by the Bazin River, it flows in a south-southwesterly direction to Lake Baskatong. It is here that it joins with another important tributary, the Gens-de-Terre River which drains Lake Cabonga. It then flows in a southerly direction to join the Ottawa River about a mile downstream from Hull at an elevation of 135 feet. The lowest portion of the river has a number of smaller tributaries among them the Desert and Picanoc rivers. The river has an irregular slope marked by rapids and falls. The basin has high elevations in the upper part, particularly in the northeastern portion, decreasing very slowly towards the south. The permeability increases in the lower portion of the basin where metamorphic formations dominate. The runoff, which has very high values in the northeastern corner, decreases to close to average values in the southern portion. This decrease is due to the combined effect of higher evaporation and infiltration.

The Du Lievre River is the second largest tributary of the Ottawa River. It rises in the Laurentian mountains in two branches, at an elevation of about 1,450 feet. It flows downstream from this junction in a generally south-southwesterly

direction where it receives the waters of the Mitchinamekus River, draining Lake Kiamika. The main stem then bows slightly southwards and, after draining Lake Poisson-Blanc and receiving the Des Ours River, it enters the Ottawa River near Masson at an elevation of 135 feet.

The whole basin is dominated by high, rough land forms and only very close to the mouth are some smoother hills encountered. In the lower portion of the basin where metamorphic Archean formations prevail, the permeability is somewhat higher than in the upper basin. However, increasing precipitation in the lower part of the basin maintains the runoff at a level above the average for the Ottawa River basin.

The Blanche River is a small tributary, whose basin separates the lower Lievre River basin from the Petite-Nation River basin. It has no hydrologic records.

The Petite-Nation River rises in a small lake near Nominique, at an elevation of about 1,550 feet and enters the Ottawa River a few miles downstream from Thurso at an elevation of 135 feet. It flows in a general southerly direction, draining a series of lakes, the most important being Lac Gagnon and Simon Lake. Its most important tributary is the Petite Rouge River. The basin receives a greater than average precipitation. In the western portion of the basin, the combination of elevations, slopes and permeabilities which are all moderate, and a large free water surface area which promotes above average evaporation, tend to reduce the available runoff.

The Rouge River drains the highest part of the Laurentian Mountains within the Ottawa River basin. It rises in several small lakes at an elevation of approximately 1,800 feet, flows in a south-southwesterly direction and receives the water of a short outlet draining the Nominique system of lakes. From here, it turns in a south-southeasterly direction to the outlet of the largest tributary, the Du Diable River and proceeds further in a southerly direction to its confluence with the Ottawa River near Calumet, at an elevation of 135 feet. Among its numerous tributaries, the most important are: the Macaza River and the Du Diable River which has in its basin Mont Tremblant, the highest point within the Ottawa River basin. High elevations, steep slopes, low permeability and high precipitation result in a high runoff for this basin.

The Nord River rises in the Laurentian mountains above Lac Brule at an elevation of about 1,400 feet, flows in a south-southeasterly direction to St. Jerome and then it bows in a southwesterly direction to Lachute. From here, it turns southward to enter the Ottawa at the head of Lake of Two

Mountains at an elevation of 70 feet. Its lower course generally follows the limit between the Laurentian mountains and the small extension of the Champlain Sea north of the Ottawa Valley. Almost the entire basin is contained within the Laurentians, a multitude of small lakes being scattered throughout. The elevations are generally high; in the northern portion they reach more than 2,000 feet with very steep slopes. The permeability is very low with precipitation being higher than average. These conditions result in the highest rate of runoff within the Ottawa River basin.

4. Hydrology

Of the 34.5 inches of rain falling throughout the entire basin each year, 17.5 inches are released in the form of runoff. Above Lake Timiskaming runoff is somewhat higher at 19.0 inches. In general, yields of the Quebec tributaries tend to be higher than those on the Ontario side, a condition which is accentuated in the lower reaches of the river. The normal increase in flow encountered with progression downstream is shown in Table B-2 for the inter-provincial reach of the river.

TABLE B-2

FLOWS AT SELECTED POINTS ON THE OTTAWA RIVER

Location	Mean Annual Flow (cfs)
Head of Lake Timiskaming	15,900
Timiskaming Dam	24,600
Otto Holden Dam	25,800
Des Joachims Dam	30,100
Chenaux Dam	36,000
Des Chats Dam	43,000
Kettle Island	59,500
Grenville	72,700
Oka	73,600

The use of the Ottawa River for hydro-electric power generation has resulted in the development of a high degree of regulation within the basin. A total storage capacity of $5,611 \times 10^3$ cfs-days or 20 per cent of the $27,700 \times 10^3$ cfs-days average runoff volume is controlled by storage dams intended primarily for power and navigation. Flood control and flow augmentation benefits have accrued through the operation of the reservoirs to store water during spring runoff for release at times of low natural flow.

Since the major reservoirs are near the headwaters of the river, they have less effect in the lower reaches of the river where the unregulated tributary area is larger. Although the greatest flow augmentation occurs during winter periods when electric power demands are highest and natural flows are lowest, flow in general has been increased substantially during warm weather periods. During critical flow periods long term average monthly flows have been increased as much as 30 per cent at the Timiskaming Dam and 25 per cent at Grenville in the summer months. For the same locations average monthly flows in the winter months have been increased as much as 150 per cent and 60 per cent respectively.

APPENDIX C

URBAN AND RURAL POPULATION SUMMARIES BY TRIBUTARY BASIN (See Figures 2.2.1, 2.3.1 and 2.3.2)

TRIBUTARY BASIN	1961	1966	1991
1. Rigquad			
Urban	-	-	-
Rural	6,726	6,146	5,360
Total	6,726	6,146	5,360
2. Ottawa (Hawkesbury-Cumberland)			
Urban	15,817	16,826	28,100
Rural	9,513	9,251	9,820
Total	25,330	26,077	37,820
3. South Nation			
Urban	15,244	19,229	31,050
Rural	47,832	46,597	46,073
Total	63,067	65,825	77,123
4. Ottawa City			
Urban	303,395	331,845	524,000
Rural	-	-	-
Total	303,395	331,845	524,000
5. Ottawa (Stittsville-Pembroke)			
Urban	19,369	18,974	25,600
Rural	10,205	11,054	13,785
Total	29,574	30,028	39,385
6. Rideau			
Urban	39,255	60,334	80,200
Rural	26,195	27,728	34,565
Total	65,450	88,062	114,765
7. Madawaska			
Urban	9,528	9,233	12,800
Rural	14,334	15,100	14,866
Total	23,862	24,333	27,666
8. Indian & Muskrat			
Urban	942	902	1,000
Rural	8,221	8,386	9,638
Total	9,163	9,288	10,638
9. Bonnechere			
Urban	11,657	12,032	18,200
Rural	7,526	7,232	7,260
Total	19,183	19,264	25,460

APPENDIX C (cont'd)

BASIN	1961	1966	1991
10. Ottawa (Deep River)			
Urban	6,512	6,659	8,600
Rural	5,965	5,385	5,360
Total	12,477	12,044	13,960
11. Mississippi			
Urban	9,390	9,765	11,080
Rural	11,739	11,380	10,981
Total	21,129	21,145	22,061
12. Fetawawa			
Urban	4,509	5,574	6,000
Rural	6,556	5,680	5,698
Total	11,065	11,254	11,698
13. Jocko			
Urban	-	-	-
Rural	95	101	100
Total	95	101	100
14. Mattawa			
Urban	4,028	3,720	4,650
Rural	4,402	4,643	5,111
Total	8,430	8,363	9,761
15. Blanche			
Urban	2,154	2,094	2,370
Rural	30,176	26,504	22,525
Total	32,330	28,598	24,895
16. Montreal			
Urban	2,688	2,678	2,650
Rural	2,094	2,601	2,667
Total	4,782	5,279	5,317
17. Ottawa (Haileybury)			
Urban	7,534	8,376	11,000
Rural	5,597	5,623	5,995
Total	13,131	13,999	16,995
18. Matabitchuan			
Urban	-	-	-
Rural	839	854	887
Total	839	854	887
19. Blanche			
Urban	-	-	-
Rural	236	203	-
Total	236	203	-

APPENDIX C (cont'd)

BASIN	1961	1966	1991
Total for Regions 4 and 5			
Urban	452,022	508,241	767,800
Rural	198,105	194,264	200,691
Total	650,127	702,505	968,491
20. Kinoyevis			
Urban	32,600	34,500	50,000
Rural	11,698	10,597	18,000
Total	44,298	45,097	68,000
21. Barriere			
Urban	-	-	-
Rural	3,338	3,225	-
Total	3,338	3,225	-
22. Cttawa (Temiscamingue)			
Urban	13,000	13,000	15,100
Rural	6,496	6,947	12,900
Total	19,496	19,947	28,000
23. Camachigama			
Urban	-	-	-
Rural	75	-	-
Total	75	-	-
24. Capitachouane			
Urban	-	-	-
Rural	76	104	-
Total	76	104	-
25. Kipawa			
Urban	-	-	-
Rural	1,814	1,929	2,200
Total	1,814	1,929	2,200
26. Beauchene			
Urban	-	-	-
Rural	41	-	-
Total	41	-	-
27. Cttawa (Temiscamingue South)			
Urban	-	-	-
Rural	44	4	-
Total	44	4	-

APPENDIX C (cont'd)

EASIN	1961	1966	1991
28. Dumoine			
Urban	-	-	-
Rural	-	38	-
Total	-	38	-
Total Region 1			
Urban	45,600	47,500	65,100
Rural	23,818	23,047	33,100
Total	69,818	23,047	98,200
29. Ottawa			
(Pontiac 1)			
Urban	-	-	-
Rural	1,736	1,991	2,600
Total	1,736	1,991	2,600
30. Schyan			
Urban	-	-	-
Rural	84	74	-
Total	84	74	-
31. Ottawa			
(Pontiac 2)			
Urban	-	-	2,000
Rural	2,596	2,549	2,000
Total	2,596	2,549	4,000
32. Noire			
Urban	-	-	-
Rural	271	227	-
Total	271	227	-
33. Colonge			
Urban	1,823	1,846	2,600
Rural	15	181	-
Total	1,838	2,027	2,600
34. Ottawa			
(Pontiac 3)			
Urban	6,100	5,500	10,000
Rural	1,154	1,765	4,000
Total	7,254	7,265	14,000
35. Guyon			
Urban	1,113	1,042	2,000
Rural	1,034	914	1,000
Total	2,147	1,956	3,000

APPENDIX C (cont'd)

EASIN	1961	1966	1991
36. Ottawa (Gatineau)			
Urban	16,600	19,877	25,000
Rural	1,481	1,471	20,100
Total	18,081	21,348	45,100
37. Gatineau			
Urban	16,600	20,900	45,000
Rural	11,662	10,394	10,000
Total	28,262	31,294	55,000
38. Ottawa (Hull)			
Urban	83,700	96,800	188,000
Rural	4,880	2,782	7,000
Total	88,580	99,582	195,000
39. Lievre			
Urban	17,700	17,800	30,500
Rural	8,241	7,528	2,500
Total	25,941	25,328	33,000
40. Blanche			
Urban	7,000	6,900	12,000
Rural	1,743	1,758	2,000
Total	8,743	8,658	14,000
41. Petit Nation			
Urban	2,200	2,200	13,000
Rural	7,094	6,385	2,000
Total	9,294	8,585	15,000
42. Ottawa (Papineau)			
Urban	2,750	2,750	10,000
Rural	2,967	3,113	-
Total	2,967	5,863	10,000
Total Region 2			
Urban	155,586	175,615	340,000
Rural	44,958	41,132	53,200
Total	200,544	216,747	393,300
43. Rouge			
Urban	8,400	10,000	25,700
Rural	11,517	11,195	24,300
Total	19,917	21,195	50,000

APPENDIX C (cont'd)

BASIN	1961	1966	1991
44. Ottawa (Argenteuil)			
Urban	15,850	16,000	42,000
Rural	921	3,309	1,000
Total	16,771	19,309	43,000
45. du Nord			
Urban	56,400	68,400	148,100
Rural	8,395	2,124	6,900
Total	64,795	70,524	155,000
46. Ottawa (Duex Montagnes)			
Urban	24,400	31,500	71,000
Rural	4,816	1,500	4,000
Total	29,216	33,000	75,000
47. Ottawa (Vaudreuil)			
Urban	20,300	25,500	55,500
Rural	1,420	1,448	4,500
Total	21,720	26,988	60,000
48. Raquette			
Urban	2,000	2,000	6,000
Rural	1,229	1,191	1,000
Total	3,229	3,191	7,000
49. Rigaud			
Urban	0	0	2,000
Rural	1,162	1,167	900
Total	1,162	1,167	2,900
Total Region 3			
Urban	127,350	153,400	350,300
Rural	29,460	21,974	42,600
Total	156,810	175,374	392,900
Total Quebec Regions 1, 2, 3			
Urban	328,536	376,515	755,500
Rural	98,236	86,153	128,900
Total	426,772	462,668	884,400
Total Ontario Regions 4, 5			
Urban	452,022	508,241	767,800
Rural	198,105	194,264	200,691
Total	650,127	702,505	968,491
Total Ottawa Basin			
Urban	780,558	884,756	1,523,300
Rural	296,341	280,417	329,591
Total	1,076,899	1,165,173	1,852,891

APPENDIX D

OTTAWA RIVER LAND USES

Industry

Data from the 1968 Census of Manufacturers indicates a total of 1,711 manufacturing establishments in the five regions mentioned above (see Table D-1). For the two Ontario regions, the data presented in Table D-1 is not completely representative since portions of some counties do not lie in the Ottawa River Basin. The table indicates the relative importance of the various counties vis a vis the major urban concentrations in the National Capital Region and Metropolitan Montreal. Although the census indicates the number of firms in each county, it does not demonstrate their relative importance in terms of the economy or water resources of the basin.

The majority of urban centres in the Eastern Ontario Economic Region which have had service roles in the past and will continue these roles in the future are located on the Ottawa River. Of the inland centres only Smiths Falls and Renfrew have shown growth potential. The riparian centres ranked in order of importance according to the number of manufacturing establishments are: Ottawa, Arnprior, Pembroke, Hawkesbury, Deep River and Chalk River. These municipalities are suitably structured to guide and control development and provide an adequate base upon which the service and industrial labour force can expand.

The northern portion of the basin is of minor importance as an industrial area, regions 1 and 5 having only 154 establishments. Of these, industries based upon the forest resources (wood industries, furniture and fixtures, paper and allied industries) account for a total of 29 establishments, 19 in Ontario, and 10 in Quebec. Approximately, 20 per cent of the labour force in Region 1 is engaged in mining, primarily in the area of Rouyn-Noranda, and the parish of Evain.

Region 2, which contains the National Capital, although having a lower growth rate than Region 3 which is adjacent to Montreal, is an important industrial centre. Of the six pulp and paper mills along the Quebec side of the Ottawa River, five are located in Region 2 and are responsible for half the industrial production of the 143 establishments in that area. In all, there are 36 industries directly related to forest resources in Region 2. In the Hull area, there is considerable diversification of industry including food and beverage processing, metal fabricating and chemical processing.

TABLE D-1

ONTARIO AND QUEBEC MANUFACTURING INDUSTRIES
OTTAWA BASIN

COUNTY	TYPE OF INDUSTRIES																			TOTAL	
	Food and Beverage	Tobacco Products	Rubber	Leather	Textile	Knitting Mills	Clothing	Wood	Furniture & Fixtures	Paper & Allied	Printing, Publishing & Allied	Primary Metal	Metal Fabricating	Machinery	Transportation Equipment	Electrical Products	Non-Metallic Products	Petroleum & Coal	Chemical & Chemical Products	Miscellaneous Products	
Temiscamingue	22	-	-	-	-	-	-	7	2	1	4	2	7	1	-	-	1	-	1	4	52
Nipissing	9	-	1	-	1	-	-	2	7	3	5	3	4	3	2	-	6	-	3	5	54
Timiskaming	23	-	-	-	-	-	-	2	5	-	5	3	2	3	1	-	3	-	3	5	54
Total for Regions 1 and 5	54	-	1	-	1	-	-	11	14	4	14	8	13	7	3	-	10	-	5	9	154
Gatineau	10	-	-	-	-	-	-	6	3	-	4	-	2	-	-	-	2	-	-	1	28
Hull	8	-	-	-	3	1	1	4	5	5	8	-	10	-	-	-	8	-	-	10	63
Papineau	19	-	-	-	-	-	-	8	2	2	3	-	2	-	-	-	1	-	-	3	40
Pontiac	4	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	1	-	4	-	12
Total for Region 2	41	-	-	-	3	1	1	18	10	8	16	-	15	-	-	-	12	-	4	14	143
Argenteuil	14	-	-	-	1	-	2	13	2	2	2	1	3	-	-	-	2	-	5	3	50
Deux-Montagnes	20	-	-	-	2	-	5	9	2	-	2	-	6	1	2	-	3	-	1	1	54
Labelle	21	-	-	-	-	-	-	6	1	-	5	-	2	-	-	-	3	-	2	-	40
Montcalm	18	1	-	-	-	-	4	6	5	-	2	-	2	-	-	-	2	-	-	5	45
Terrebonne	48	1	1	4	6	2	25	33	21	7	22	4	17	3	7	1	17	2	7	16	244
Vaudreuil	13	-	-	-	2	1	1	7	3	-	7	1	3	-	3	-	7	-	-	2	50
Total for Region 3	134	2	1	4	11	3	37	76	34	9	40	6	33	4	12	1	34	2	15	27	485
Carleton	47	-	-	2	9	-	6	16	42	6	56	7	44	3	6	12	22	-	8	47	333
Dundas	21	-	1	-	1	-	-	2	-	-	4	1	3	-	-	-	1	-	1	2	37
Frontenac	23	-	-	1	5	-	-	5	11	-	8	2	10	-	6	2	6	-	2	7	88
Glengarry	20	-	-	-	-	1	3	1	3	3	5	2	3	-	3	-	-	-	1	2	36
Lanark	24	-	-	1	6	1	1	6	4	1	8	-	10	1	2	5	1	-	4	6	81
Leeds	19	-	-	-	-	-	1	6	1	-	8	1	12	3	2	3	2	-	3	4	65
Prescott	24	-	-	-	-	1	-	3	1	1	4	-	6	-	-	2	-	-	1	1	44
Renfrew	26	-	-	-	4	-	3	8	5	1	12	4	5	-	3	4	6	-	2	7	90
Russel	20	-	-	-	-	-	-	4	1	-	2	-	-	-	-	-	-	-	-	-	27
Stormont	26	-	1	2	10	1	5	1	4	-	2	-	4	-	1	1	9	-	12	8	87
Total for Region 4	261	-	2	7	36	4	22	53	72	12	111	18	98	7	23	30	48	-	41	86	931

Region 3 is the most important and fastest growing industrial area of the three Quebec regions. This region has over twice the number of manufacturing establishments of the other two Quebec regions combined. The forest-based industries accounting for 119 of the 483 establishments in the region. Future growth in Region 3 will largely result from the marked diversification of industries in the area as well as proximity to the Montreal market.

Agriculture

Examination of the Dominion Census through recent decades reveals that a trend common to most agricultural areas is presently prevailing in the Ottawa River basin. Total farmland area, and improved farmland area has actually declined in recent decades. The resident population in farming areas which is engaged in agricultural activities has not grown and in some areas is decreasing. In the Ontario portion of the basin, the dollar share of the provincial value of livestock is decreasing and the average value per acre of all field crops is approximately 10 per cent below the provincial average. Throughout the Eastern Ontario Economic Region, the combination of poor soils difficult topography, location, market size, and lack of farm capital to cope with changing technology have rendered agricultural enterprises unrewarding. The number of farms in this region declined from 24,638 in 1961 to 17,180 in 1966, while farm capital investment in 1961 was \$117 per acre, compared to \$201 per acre across the whole province. Whether allowed to take place naturally, or whether induced by government program, the trend is well established toward fewer and larger farms operated by fewer farmers.

In the Quebec portion of the Ottawa basin, the agricultural industry occupies a place of importance in the counties of Papineau, Labelle, Argenteuil, Deux-Montagnes, Vaudreuil, Hull, Terrebonne and a small part of Temiscamingue. In order of importance, the principal agricultural products in 1961 were dairy products, beef, pork, potatoes and forest products. A large part of the dairy produce from the Hull-Gatineau area is sold outside these two counties, much of it in Ontario.

The data presented in Table D-2 indicates the location and relative size of improved farmland by tributary basin in Ontario and by county in Quebec. Table D-3 indicates the farm size, population, and dollar value of all crops across the Ottawa basin. The South Nation and Rideau watersheds are by a wide margin the major agricultural basins tributary to the Ottawa River. In Ontario, the areas draining directly to the Ottawa

TABLE D-2

LOCATION AND RELATIVE SIZE OF IMPROVED FARMLAND
(1966 Farm Census - Ottawa River Basin)

BASIN	Farm Popu- lation	Total Area	ACREAGE			
			Under Crops	Summer Fallow	Past- ure	Wood- land
COUNTY						
Temiscamingue Total	10,926	312,873	116,692	596	713	71,548
Region 1	10,926	312,873	116,692	596	713	71,548
Pontiac	5,191	235,889	75,487	998	42,991	88,153
Gatineau	6,037	279,657	72,729	906	38,413	125,192
Hull	975	29,657	12,057	200	6,029	5,855
Papineau Total	6,119	232,418	77,299	831	41,100	82,031
Region 2	18,322	1,047,317	237,572	2,935	128,533	301,231
Montcalm	4,528	81,009	42,139	275	13,449	20,570
Labelle	6,956	195,783	58,331	996	25,102	77,871
Argenteuil	2,916	119,205	39,818	258	20,674	42,136
Terrebonne	4,678	88,708	36,470	491	12,164	28,224
Deux Montagnes	7,354	122,062	74,301	1,203	19,303	19,230
Vaudreuil Total	3,418	72,813	44,792	246	14,238	8,613
Region 3	29,850	679,580	295,851	3,469	104,930	196,644
Rigaud* Ottawa (Hawkesbury- Cumberland)	3,505	126,329	62,308	368	26,925	15,266
South Nation	4,462	141,185	79,568	634	33,281	13,194
Bonnechere	24,178	765,747	401,350	3,257	172,001	77,969
Ottawa (Stittsville- Pembroke)	2,979	194,039	43,901	466	18,928	82,524
City of Ottawa	4,470	215,436	81,869	672	43,008	49,102
Rideau	545	16,320	8,409	212	4,334	812
Mississippi	11,065	563,448	178,126	1,804	80,668	121,527
Madawaska	5,538	371,339	81,993	507	42,333	144,849
Petawawa*	4,193	277,000	45,082	366	23,022	150,786
	96	6,124	1,541	43	457	2,737

TABLE D-2 (cont'd)

BASIN	Farm Popu- lation	Total Area	ACREAGE			
			Under Crops	Summer Fallow	Past- ure	Wood- land
Indian and Muskrat Ottawa (Deep River)	2,884 203	146,523 10,971	50,148 2,292	297 56	24,910 837	44,548 5,484
Blanche*	1,980	100,262	45,349	382	12,524	15,942
Montreal* Ottawa (Haileybury) *	45 1,646	2,485 81,517	1,178 35,009	10 280	343 11,784	881 13,031
Mattawa*	891	49,786	11,840	263	6,069	21,386
Total Regions 4 and 5	68,680	3,068,511	1,129,963	9,617	501,434	760,020
BASIN TOTAL	127,778	5,114,281	1,780,078	16,617	781,610	1,329,443

SOURCE: Dominion Census - 1966 - Agriculture, Quebec and Ontario
Catalogue 96-606, Vol. IV

* Data not complete for these basins.

TABLE D-3

FARM SIZE, POPULATION AND DOLLAR VALUE OF FIELD CROPS
(1966 Farm Census - Ottawa River Basin)

COUNTY	ACREAGE			\$ Value per Acre of all Field Crops
	Total Farmland	Total Land Area	Farm Population	
Carleton	269,000	613,900	9,524	46
Dundas	161,900	246,400	6,597	38
Frontenac	189,600	1,024,500	6,530	43
Glengarry	194,000	304,500	6,946	35
Grenville	109,000	304,700	4,515	43
Lanark	279,500	728,300	6,913	43
Leeds	244,700	576,000	8,274	40
Prescott	209,700	305,800	7,401	41
Renfrew	326,300	1,905,700	11,292	46
Russell	162,100	271,000	7,252	53
Stormont	143,700	264,100	5,883	40
TOTAL	2,289,500	6,544,900	81,123	53.7 (Average)
Temiscamingue	169,001	5,745,300	10,926	13
Pontiac	123,569	6,118,400	5,191	11
Gatineau	118,454	1,556,500	6,073	9
Hull	20,057	89,000	975	14
Papineau	124,907	1,011,800	6,319	17
Montcalm	57,446	2,492,200	4,528	61
Labelle	89,139	1,530,900	6,956	12
Argenteuil	44,030	501,100	2,916	24
Terrebonne	53,528	500,500	4,678	57
Deux Montagnes	96,840	178,600	7,354	62
Vaudreuil	660,701	128,600	3,418	32
TOTAL	957,672	19,852,900	59,134	23

SOURCE: Dominion Census - 1966 - Quebec and Ontario
Catalogue 96-606, Vol. IV

River collectively account for a large portion of the area actively farmed. The Bonnechere, Mississippi and Madawaska watersheds, on the other hand, contain a relatively large proportion of woodland. In the Quebec portion of the basin, those counties devoting the highest proportion of land to crops in 1966 were: Deux-Montagnes, Vaudreuil, Terrebonne, and Montcalm. Those counties with the highest proportion of farming areas still in woodlands were: Gatineau, Pontiac and Labelle. Using value per acre of all field crops as a measure of the productivity of agricultural areas, it is apparent that Russell, Carleton and Renfrew counties in Ontario and Deux-Montagnes, Montcalm and Terrebonne counties in Quebec (also the major farming areas) are the most productive.

Tourism

The Ottawa River Basin is located within close proximity of major population centers in Ontario, Quebec and the northeastern United States. In addition, transcontinental railway and highway traffic must pass through the Ottawa valley. The National Capital, which itself is a primary tourist attraction, is a focal point for much of the tourist trade in the area. Each year there are approximately one million visitors to the Parliament Buildings alone. These factors, among others, have caused tourism to become an increasingly important part of the economy of the basin.

Ontario data (Department of Tourism and Information, 1970) indicates the relative contribution of the Ottawa River basin to the Ontario tourist industry. The area of the Ontario portion of the basin is 7 per cent of the total area of the province. During 1968, expenditures on tourism within the basin amounted to \$122.6 million which represents 11 per cent of the total expenditures on tourism within the province. Of the \$122.6 million, 40 per cent was generated by residents of Ontario and 30 per cent by residents of the United States. When considered collectively, the tourist industry is one of the largest economic forces in the basin. By comparison, the above expenditure on tourism in Ontario is approximately equal to the dollar value of all field crops grown within the Ontario portion of the basin.

APPENDIX E

OTTAWA RIVER WATER USES

1. Water Supply

Municipal

Fifteen municipalities (7 in Ontario and 8 in Quebec) use the Ottawa River for their domestic water supplies. Other municipalities located adjacent to the river take water for domestic supplies from either tributaries to the Ottawa River or wells. River water is used for the potable water supply at the hydro-electric generating stations located on the river. A total of 56 mgd of water is taken directly from the Ottawa River for municipal water supply, 45 mgd being consumed in Ontario and 11 mgd in Quebec. The two major users, Ottawa and Hull use 38.5 and 7.5 mgd respectively. Table E-1 lists the municipalities using Ottawa River water for domestic supply, their rates of water consumption and type of treatment.

Industrial

The pulp and paper industry is the largest single industrial water user. Seven pulp mills located adjacent to the Ottawa River use 233 mgd of the total 303 mgd industrial consumption. The Rolphton nuclear power plant and the Chalk River nuclear laboratories require 66 mgd of river water for condenser cooling. A new steel mill under construction near Hawkesbury will use 1.4 mgd of river water for cooling equipment used in rolling steel bars and rods. Hilton Mines located upstream from Bryson uses river water in its ore separation process. The industries located along the river, including the pulp and paper mill of the James MacLaren Company at Masson and the Kipawa mill of the Canadian International Paper Company at Temiscaming, that use water from tributaries to the Ottawa River or from municipal water supplies require approximately 100 mgd which is included in Table E-2 as tributary water takings. Table E-2 gives the names of industries using water, the location of the industry, the daily consumption and the type of water use.

Agricultural

Water withdrawals from the Ottawa River for irrigation purposes are limited. At present, permits have been issued only in Ontario for this purpose, the total allowable taking being 1 mgd of water.

TABLE E-1

MUNICIPALITIES TAKING DOMESTIC WATER SUPPLIES
FROM THE OTTAWA RIVER

Municipality	Consumption (Thousands of Gallons/day)	Type of Treatment
Province of Ontario		
City of Ottawa		
- Britannia	14,180	alum, filtration, chlori- nation, fluoridation
- Lemieux Isle	24,340	alum, filtration, chlori- nation, fluoridation
Town of Hawkesbury	2,000	alum, silica, lime, fil- tration, chlorination
Town of Pembroke	1,860	screening, chlorination
Canadian Forces Base and Village of Petawawa	1,310	screening, sedimentation, chlorination
Town of Deep River	620	filtration, chlorination, fluoridation
Town of Rockland	350	flocculation, filtration, chlorination
Town of Haileybury	330	alum, filtration, chlori- nation
Total	44,990	
Province of Quebec		
City of Hull	9,000	chlorination
Town of Gatineau	1,800	filtration, chlorination
Town of Aylmer	650	filtration, chlorination
Village of Deschenes	180	filtration, chlorination
Village of Campbell's Bay	120	chlorination
Village of Quyon	100	chlorination
Village of Bryson	80	chlorination
Village of Portage-du- Fort	60	chlorination
Village of Chapeau	60	chlorination
Total	10,950	
Total mean daily consumption from Ontario and Quebec	55,940	

TABLE E-2

INDUSTRIES TAKING WATER FROM THE OTTAWA RIVER AND TRIBUTARIES

Industry	Municipality	Consumption (mgd)	Water Use
a) OTTAWA RIVER			
Province of Ontario			
HEPCO Nuclear power plant*	Rolphton	26	condenser cooling
AEC nuclear laboratories**	Chalk River	40	condenser cooling
E.B. Eddy	Ottawa	6.7	paper mill
CIP Hawkesbury	Hawkesbury	24	pulp & paper mill
Industrial Fasteners	Hawkesbury	1.4	cooling water for hot rolled steel +
	Total	98.1	
Province of Quebec			
Hilton Mines	Bristol	0.6	ore separation
Consolidated Bathurst	Portage-du-Fort	14.5	pulp & paper mill
E. B. Eddy	Hull	33.2	pulp & paper mill
CIP Gatineau	Gatineau	45.6	pulp & paper mill
Thurso Paper	Thurso	10.4	pulp & paper mill
	Total	104.3	
b) TRIBUTARIES			
CIP Kipawa	Temiscaming	90	pulp & paper mill (Kipawa Lake)
James MacLaren	Masson	8.8	pulp & paper mill (Du Lievre River)
Others		1.9	industries with small takings located along the length of the river
	Total	100.7	
* HEPCO	-	Hydro Electric Power Commission of Ontario	
** AEC	-	Atomic Energy of Canada	
*** CIP	-	Canadian International Paper	
+	-	Plant scheduled to commence production in 1971.	

2. Recreation and Aesthetics

The utilization of water for recreational purposes is clearly recognized in the development of present day water management programs based upon the principle of multiple use. At one time water was valued almost exclusively as a source of potable and industrial supply and for other uses such as power production and commercial navigation. These uses have increased as a result of the growth of population and the accompanying increase in industrialization. However, the importance of each use must be re-appraised in the light of increasing public demand for better recreational facilities and for the restoration of a healthy balance of fisheries and wildlife. This change has resulted from an expanding urban population with increasing amounts of leisure time, and increased disposable incomes; improved transportation facilities and increased emphasis on outdoor recreational activities are other factors. As a result of these changes, water is now valued as a key public resource, not only as a base for recreational activities but for its aesthetic qualities as well.

The Ottawa River Basin offers an almost unlimited potential for recreational development. Much of the basin is characterized by the rugged, forested, upland areas of the Precambrian Shield, containing numerous lakes and rivers. This region, in addition to its spectacular scenic qualities offers resources for a wide-variety of recreational pursuits. The lowlands of the Ottawa Valley bordering the lower reaches of the Ottawa River contrast sharply with the Precambrian Shield enhancing the scenic qualities of the valley in the Pembroke-Arnprior area and along much of the Quebec shoreline of the lower Ottawa River. The relative paucity of lakes in the lowland areas and the predominant agricultural land use, limits its recreational potential to a considerable degree.

Major factors in determining the distribution of tourism and water-based recreational activities in the basin are the location and degree of development of transportation facilities, particularly highways. To a marked degree, railways, major highways and secondary roads follow river valleys. In Ontario, Trans Canada Highway 17 follows the Ottawa River for much of its length and is the major east-west route linking Quebec and the maritime provinces with western Canada. Highway number 8 in Quebec follows the Ottawa River as far west as Chapeau where it connects with Highway 17 by the interprovincial bridge near Pembroke. From Chapeau, secondary roads provide access only as far west as Fort William. From North Bay, Highway 63 extends to the Town of Temiskaming at the lower end of Lake Timiskaming and Highway 46 follows the east shore north to the head of the lake. Highways are developed to a relatively greater degree in

tributary basins of the lower Ottawa River. In Ontario, this includes the greater part of the lakeland areas of the upper Rideau, Mississippi and Madawaska river basins. The Nipissing District is noticeably less developed in this regard. In Quebec, major routes north from Highway 8 follow the Gatineau, Du Lievre, Petite Nation and the upper Rouge rivers. In general, throughout Argenteuil, Papineau, Labelle, Gatineau and the eastern portion of Pontiac counties roads are extensively developed.

Although roads and other public transportation facilities govern to a degree the intensity and distribution of tourism and water recreational use, the exploitation of high quality sport fishing areas and the use of wilderness canoe routes in more remote areas of the basin are significant.

2.1 Recreational Use of the Ottawa River

The following discussion deals primarily with known uses and related facilities for the interprovincial section of the Ottawa River. While lakes on the system upstream from Lake Timiskaming have a high recreational potential, present use is less developed relative to downstream reaches owing to the low population densities and as yet, limited accessibility.

In Lake Timiskaming and downstream, recreational use of the river for the most part is high. Contributing factors include the concentration of much of the population of the basin along the river; major highways and secondary roads which provide good access (with the exception of the Quebec shoreline in Pontiac and Timiskaming counties which extend from Allumette Lake to the Town of Temiskaming and the Ontario shoreline of the lower part of Lake Timiskaming); the geographical position of the river which forms a primary east-west transportation route; and the presence of the national capital which exposes the region to a high level of non-resident tourist trade. Furthermore, the river, consisting of a series of natural and impounded lake-like expansions, is ideally suited to recreational uses and in itself comprises a very significant portion of the surface water area of the basin.

The Ottawa River is utilized for a wide variety of water-based recreational activities. These include bathing, pleasure boating, sport fishing, waterfowl hunting and aesthetic enjoyment. With the exception of some statistics pertaining to sport fishing, cottage development and use of provincial parks and camp grounds, little information is available on the intensity of recreational activities. However, some measure of the degree and extent of recreational use can be obtained by examining the distribution of public recreational facilities on the river. Table E-3 presents statistics on various facilities

TABLE E-3

Distribution of Water Based Recreational Facilities
on the Ottawa River

LOCATION	CAMPING GROUNDS			RECREATIONAL FACILITIES		
	Number	Acreage	Camp Sites	Parks,	Launch Ramps, Marinas	Beaches Wharves
ONTARIO						
Carillon Dam to Chaudiere Dam	4	1,009	391	10	14	3
Chaudiere Dam to Chenau Dam	4	450	231	10	8	2
Chenau Dam to Des Joachims Dam	5	134	348	1	9	3
Des Joachims Dam to Timiskaming Dam	3	825	197	3	5	0
Lake Timiskaming	2	10	59	0	2	0
QUEBEC						
Lake of Two Mountains	1	700	-	-	-	-
Carillon Dam to Chaudiere Dam	1	-	325	1	7	-
Chaudiere Dam to Chenau	0	-	-	5	3	-
Chenau Dam to Des Joachims Dam	1	-	-	3	6	-

Note: (-) signifies that data were not available.

SOURCES: 1) Ontario Department of Tourism and Information Publications
"Ontario Campsites" and "Ontario Marine Facilities"
2) Ministere du Tourisme, de la Chasse et de la Pêche.

operated by governmental and private agencies or individuals which provide access for recreational use of the river. Parks, beaches, wharfs and launch ramps are common and well dispersed along the river. The greatest number of these facilities are to be found on the lower river, particularly in the vicinity of Ottawa-Hull and on Lake Deschenes. The number of marinas (total of 8) is relatively small considering the extent of river and amount of boating use. Listed are those that are located directly on the river catering to local boating traffic and pleasure cruising. In many instances, however, gas and oil supplies can be obtained from roadside service stations located in close proximity to public wharfs; and other marina-type services are offered by business enterprises situated in local municipalities.

Boating

A total of seven boating or yacht clubs are based along the Ontario shore of the Ottawa River, four at Ottawa, one at Arnprior and two at Deep River. Britannia Yacht Club, situated on Lake Deschenes near Ottawa, is the largest with an active membership of 1,300 and a total of 340 boats ranging from cruising yachts to small day sailers. Other clubs are considerably smaller and interest varies from sailing to motor boating (Deep River Motor Boat Club) and rowing (Ottawa Rowing Club). The extent of navigable waters above Ottawa-Hull is limited by natural obstructions and power developments and most boating activity is confined to local sections of the river. The lower Ottawa River is navigable from Ottawa to Montreal by means of the Carillon and the Ste. Anne locks which permit access to the St. Lawrence River. This section of the river is also linked with Lake Ontario by the Rideau Canal. The number of pleasure vessels using these locks is presented in this Appendix in Section 5, Navigation.

Camping

Camping facilities located on the Ottawa River are common along most of its length (Table E-3). These areas provide further public access for use of the river and in conjunction with campsites, provide facilities directly related to recreational use (bathing beaches, docks, launch ramps, etc.). Indeed activities related to camping are, to a large measure, water oriented. Most of the camping facilities on the river are administered by provincial governmental agencies (for these, some statistics are available on annual use). Table E-4 shows camping facilities and use in terms of total visitation, number of campers and camper-days during 1968 for the three Ontario provincial parks on the river (Fitzroy on Lake des Chats and Driftwood and Antoine parks on Holden Lake). These three parks

TABLE E-4

ONTARIO PROVINCIAL PARKS ON THE OTTAWA RIVER
(Facilities and Use, 1968)

Location	Park	Acreage	No. of Camp- sites	Total Visit- ation	Total Campers	Camper- Days
Ottawa to Chenau	Fitz- roy	434	251	118,951	17,943	27,250
Rolphtcn to Lake Timis- kaming	Drift- wood	655	98	9,431	6,418	14,227
	Antoine	23	29	8,885	769	1,349
TOTAL	3	1,112	238	137,267	25,130	42,826

SOURCE: Ontario Department of Lands and Forests, Provincial
Parks of Ontario Statistical Report, 1968.

have been operating essentially at capacity for at least the past ten years. In 1968, total visitation was in the order of 150,000 visitor-days. Carillon Provincial Park, occupying an area of 1,700 acres on the Ottawa River just upstream from the Carillon power dam was created in 1970 and in the first year of operation provided (in addition to picnicking facilities), 100 campsites which were utilized to capacity. It is expected that an additional 200 campsites will be provided by 1971 by which time this development will have more than doubled the Ontario provincial park facilities that were on the river prior to 1970. In Quebec, the provincial government administers two parks situated on the lower Ottawa River offering picnicking, camping and facilities supporting recreational use of the river. Deux Montagnes park, comprising 700 acres on the north shore of the Lake of Two Mountains, was utilized by 85,000 visitors in 1964. The Dollard-des-Ormeaux park, which was created in 1967, is situated on the north shore of the lower river in two sections, one just upstream from the Carillon dam and the other further upstream in the vicinity of Papineauville. The park occupies an extensive length of shoreline in these two areas and furnishes a total of 325 campsites.

Tourist Resorts

Other public facilities which relate directly or indirectly to recreational use of the river are tourist establishments. Table E-5 lists the number and capacity of tourist establishments along the Ottawa River (extending to and including Highway 17 in Ontario and Highway 8 in Quebec, but excluding the cities of Ottawa and Hull). Those not located on the river relate only in an indirect way to the recreational use of the river but the list does indicate the magnitude of accommodation facilities which depend largely on tourism. Those located on the river are to a large measure directly dependent on clientele seeking recreational activities on the river. These establishments include resorts and lodges, hunting and fishing camps, commercial cottages or cabins and in some cases motels; they provide, in addition to accommodation, opportunities for swimming, boating, hunting and fishing and in some cases boat rentals and guiding services for anglers and hunters.

Cottage Development

Recreational use of the Ottawa River is further illustrated by the degree and extent of cottage development and by an examination of the recreational pursuits of cottage residents on the river. The number of cottages located on the Ottawa River in Ontario (based on Ontario Hydro records for the seasonal-residential class) is given below:

Location	Number of Cottages
Pt. Fortune to Ottawa	690
Ottawa to Chenaux	1,612
Chenaux to Rolphton	485
Rolphton to Lake Timiskaming	17
TOTAL	2,804

It is estimated that about one-third of the cottages in Ontario as a whole are without electricity. Although the percentage in this regard for the Ottawa River is probably not as high, the total given above is nevertheless a conservative estimate. Information concerning cottage development on the Ottawa River in Quebec is not readily available. However, on the basis of field counts in areas of significant cottage development and information provided by cottage associations, the following estimate of the number of cottages on the Quebec shore of the river (for the areas indicated) was derived:

Location	Number of Cottages
Carillon to Hull	154
Hull to upper Lake des Chats	580
Lower Allumette and Allumette lakes	185
Allumette Lake to Lake Timiskaming	0
lower Lake Timiskaming	50
TOTAL	969

This estimated total of approximately 3,800 cottages does not include those in the section from Carillon to Montreal, along the Grand Calumet Channel and Quebec shore of Coulonge Lake or on upper Lake Timiskaming. Considering these areas, the number of cottages on the river is perhaps closer to 5,000.

Additional information relating to use of cottages and recreational activities was derived from interviews of cottagers from various areas on the river. Sixty-four cottage units were censused, the majority being in areas of greatest cottage density. While this represents only one to two per cent of the total number of cottages, the general uniformity of results among the cottages sampled would indicate that the information derived is probably representative of the cottage population as a whole.

About 93 per cent of cottagers reside permanently in municipalities along the river and particularly in municipalities in the vicinity of the cottage location. For instance, cottagers on Lake Deschenes are largely from the cities of Ottawa and Hull, on Lake des Chats they are from Ottawa, Hull, Arnprior and other smaller centres in between and on Allumette and Lower Allumette

TABLE E-5

Distribution of tourist establishments*

LOCATION	TOTAL		ON THE OTTAWA RIVER	
	Number	Capacity (persons)	Number	Capacity (persons)
Ontario				
Quebec Province to South Nation River	16	588	3	104
South Nation River to Ottawa	21	725	1	80
Ottawa to Cheneaux	35	1,361	17	462
Cheneaux to Rolphton	48	1,727	10	192
Rolphton to Lake Timiskaming	12	450	4	178
Lake Timiskaming	13	420	8	178
TOTAL	145	5,281		1,194
Quebec**				
		(rooms)		
Fasset to Plaissance	11	127		
Plaissance to Hull	26	367		
Hull to Portage- du-Fort	10	150		
Portage-du-Fort to Fort William	22	235		
TOTAL	69	879		

* Included are those along the Ottawa River bounded by and including Ontario Hwy. 17 and Quebec Hwy. 8 but exclusive of the cities of Ottawa and Hull.

** No breakdown available for establishments located directly on the Ottawa River.

SOURCES: 1) Ontario Department of Tourism and Information publications "Where to Stay in Ontario" and "Ontario Accommodation Guide, Northern"
2) SOTAR, 1969 "L'Ouest du Quebec, Etude en vue de la Creation d'un Reseau Regional de Parcs Touristiques et recreatifs".

TABLE E-6

Interest shown by Ottawa River cottagers in
various water-based recreational activities
(Based on 64 cottage units interviewed)

Interest Rating	Percentage of Cottagers			
	Swimming	Boating	Angling	Waterskiing
5 High 4	75.0	45.3	37.5	14.1
3 Moderate 2	12.5	29.7	21.9	17.2
1 Low 0	12.5	25.0	40.6	68.7
Average Rating	3.9	2.7	2.5	1.3

lakes most cottagers are from Pembroke. The average number of occupants per cottage is 4.5 and, on the average, cottages are occupied for 82 days of the year resulting in a yearly occupancy of 352 man-days per cottage. Table E-6 indicates the interest shown by cottagers in various active recreational pursuits. Interest was rated on a priority scale (0-5) indicating the extent to which cottagers participated in the particular activity. In order of priority, swimming, boating, angling and water-skiing are the most important recreational uses made of the river by cottagers. Ninety-two per cent of cottagers utilize the river for swimming and 75 per cent rate this use as high. Pleasure boating, excluding boat use specifically for angling, hunting or water-skiing, is rated moderate to high in importance by 75 per cent of cottagers. Eighty-four per cent of cottagers own on the average 1.5 boats per cottage unit. Approximately 84 per cent of cottagers participate to some extent in sport fishing. Among those indicating moderate to high interest (59 per cent) the average time spent fishing each year is in excess of 500 hours. Although water-skiing is of lesser importance, at least 42 per cent of cottagers participate to some extent in this sport.

3. Power Production

The availability of waterpower from the Ottawa River and its tributaries contributed to the development of many of the early settlements in the basin. The original Chancery Dam on the north branch of the Mississippi River at Almonte was constructed in 1824. This dam was the earliest of a number of structures used to harness the water power of the basin.

Hydro-electric Power

The Ottawa River basin has been intensively developed to facilitate the production of hydro-electric power. The combination of large lakes in the headwater areas that serve as storage reservoirs and the uniform rate of fall along the length of the river permits maximization of the energy potential of the river.

The first hydro-electric power development on the main stem of the river was at Chaudiere Falls in 1889. Other main stem installations were completed at Des Quinze Rapids (1923), Bryson (1925) and Des Chats Falls (1932). In 1943, an Ontario-Quebec agreement was reached under which Ontario and Quebec each received rights to one-half of the hydro-electric power generating capacity of the Ottawa River. The two provinces negotiated an arrangement under the agreement whereby the power development sites along the interprovincial section of the river were assigned to one or the other of the two jurisdictions. Ontario Hydro constructed the Otto Holden Generating station at

La Cave, the Des Joachims Generating Station at Rapide Des Joachims and the Chenaux Generating Station at PortageDu-Fort during the period from 1950 to 1953. Hydro Quebec completed its Carillon Generating Station at Pointe Fortune in 1964. Only three powersites, located at the Rocher Fendu Channel south of Grand-Calumet Island, the Paquette site near the downstream end of Allumette Island, and the Premiere Chute site at the head of Lake Timiskaming, remain undeveloped. Several other potential sites are available on the tributaries to the Ottawa River.

Recently, Hydro-Quebec has completed its power development at Rapide des Iles on the Ottawa River in the Quebec section of the basin upstream from Lake Timiskaming.

To date, approximately 3 million kilowatts of capacity have been developed in the entire basin of which 1.8 million kilowatts is generated on the main stem of the Ottawa River. Table E-7 is a list of power developments within the basin, including the river upon which the development is located, the owner and the installed generating capacity in kilowatt-hours for each development. (Electric Power of Canada, Dept. of Energy, Mines and Resources, Inland Waters Branch, 1968).

Nuclear Power

Ontario Hydro operates the nuclear power demonstration plant at Rolphton, Ontario. The plant was built by the Atomic Energy of Canada Limited, Ontario Hydro and Canadian General Electric Company. On April 10, 1962, the reactor was placed in service and on June 4 of that year, the first electricity produced in Canada by nuclear fission was sent into the Ontario transmission network. Since that time, the plant has been generating 20,000 kilowatts of power. When operating at capacity, the plant requires 26 mgd of condensor cooling water which is taken from the Ottawa River. In addition to producing power, the plant serves as an experimental station and as a nuclear training centre for Ontario Hydro personnel.

4. Wastewater Disposal

Serious water quality degradation exists in sections of the Ottawa River downstream from the City of Ottawa and the Town of Temiskaming. The water quality problems that exist result primarily from the discharge of wastes inadequately treated municipal and industrial wastes.

TABLE E-7

HYDRO-ELECTRIC POWER DEVELOPMENTS
IN THE OTTAWA RIVER BASIN

Location	Development	Owner	Total Generation Capacity
Ottawa River			
	Carillon	QHEC	654,500
	Des Joachims	HEPCO	360,000
	Otto Holden	HEPCO	205,200
	Chenault	HEPCO	122,450
	Rapide-des-Iles	QHEC	109,890
	Quinze Falls	QHEC	89,600
	Chats Falls	HEPCO	89,300
	Chats Falls	OVPC	89,300
	Rapid VII	QHEC	57,000
	Bryson	QHEC	56,000
	Rapid II	QHEC	48,000
	Premiere Chute	QHEC	31,000
	Chaudiere Falls #2	QHEC	27,280
	Chaudiere Falls #4	OHEC	11,250
	Eddy	EBEC	7,920
	Chaudiere Falls	EBEC	7,920
	Hull 2	QHEC	4,386
	Winneway	LMC	2,338
			1,974,714
Gatineau River			
	Paugan	QHEC	201,975
	Chelsea	QHEC	144,000
	Farmers Rapids	QHEC	98,250
	Corbeau	QHEC	2,000
			446,225
Madawaska River			
	Barrett Chute	HEPCO	152,400
	Mountain Chute	HEPCO	139,500
	Stewartville	HEPCO	61,200
	Calabogie	HEPCO	4,000
			357,100

TABLE E-7 (cont'd)

Location	Development	Owner	Total Generation Capacity
Montreal River			
	Lower Notch (under construction)	HEPCO	228,000
	Upper Notch	HEPCO	9,600
	Indian Chute	HEPCO	3,240
	Hound Chute	HEPCO	2,800
	Fountain Falls	HEPCO	2,000
			245,640
Du Lievre River			
	Masson	MQPC	95,200
	High Falls	MQPC	85,000
	Dufferin Falls	JMC	38,250
	Buckingham	ERC	7,531
	Mont Laurier	QHEC	2,300
			228,281
Riviere Des Prairies	Montreal Island	QHEC	45,000
Gordon Creek	Kipawa	QHEC	17,120
Rouge River	Bells Falls	QHEC	4,800
Rideau Canal	Jones Falls	GELW	2,580
Rideau River	Rideau Falls	DPW	2,000
Mississippi River	High Falls	HEPCO	2,100

LIST OF OWNERS:

QHEC	-	Quebec Hydro-Electric Commission
HEPCO	-	Hydro-Electric Power Commission of Ontario
OVPC	-	Ottawa Valley Power Company
EBEC	-	E. B. Eddy Company
LMC	-	Lorraine Mining Company Limited
MQPC	-	MacLaren-Quebec Power Company
JMC	-	James MacLaren Company Limited
ERC	-	Electric Reduction Company
GELW	-	Cananoque Electric Light & Water Supply Co. Ltd.
DPW	-	Department of Public Works, Government of Canada

Municipal

There are thirty-five municipalities located adjacent to the Ottawa River or its tributaries that discharge wastes which affect the water quality of the Ottawa River. Twenty of these municipalities are located in Quebec and contribute approximately 20,000 lbs of BOD, while fifteen are located in Ontario and contribute 50,000 lbs of BOD. Of the municipalities in Quebec, sixteen have no treatment, one has primary treatment and three have secondary treatment, whereas in Ontario, five have no treatment, five have primary treatment and five have some form of secondary treatment. Each municipality and the status of its waste treatment program is listed in Table 3.2.1 of the text.

Industrial

There are four significant sources of industrial wastes from Ontario. Several small industries discharge some wastes to the Ottawa River, but the majority of their loadings are diverted to municipal treatment systems. Within Quebec, there are fifteen industries of which six are pulp and paper mills, and one is a slaughterhouse, which account for 99 per cent of the industrial BOD loading from Quebec. The remaining eight industries are small operations that will eventually discharge to municipal sewage systems. Details of the individual waste discharges appear in Tables 3.2.2 and 3.2.3 of the text.

5. Navigation

Historically, the Ottawa River was one of the main communication routes used by explorers, fur traders and settlers as they journeyed to and from the west.

Early uses of the river for travelling precipitated interest in the Ottawa River as a navigable waterway from Montreal to Georgian Bay via the Mattawa and French rivers. The Canadian government initiated feasibility studies on this route in 1904 and in 1908 published a detailed report recommending the project, to be known as the Georgian Bay Ship Canal. The canal, which was never developed, would have involved the construction of 45 control weirs, 27 locks and 9 upstream reservoirs to be utilized for flow augmentation during the navigation season.

Navigation on the Ottawa is now confined to travel between hydro dams or to the section of the river from Montreal to Ottawa which joins the Rideau Canal system in Ottawa. The Ste. Anne-De-Bellevue Lock between Lake of Two Mountains and Lake St. Louis and the Carillon Lock at the Carillon Generating Station are the only navigable locks on the river.

Shipping and Boating

The Ottawa River has never been developed as a commercial waterway. Each year approximately 1,500 vessels use the Carillon Lock, over 98 per cent being pleasure craft. Approximately 400 pleasure craft pass through the Rideau locks at Ottawa during the navigation season each summer. Very limited commercial shipping is practiced on the Ottawa River.

Log Driving

The Upper Ottawa Improvement Company and the Gatineau Boom Company are responsible for the driving of logs along the Ottawa River. These companies are owned by the various pulp and paper companies located in the Ottawa River basin and operate under a no profit lease agreement with the Canada Department of Public Works. The Upper Ottawa Improvement Company is responsible for log driving in the section of the basin upriver from the Chaudiere Dam at Ottawa, while the Gatineau Boom Company is responsible for the section of the basin downriver from the Chaudiere Dam, including the Gatineau River.

Approximately 1 million cords of wood are transported by water within the Ottawa River basin each year during the period from May to November, saw logs accounting for about 5 per cent of this quantity. Water depths in the river are maintained at suitable levels to facilitate log towing by tugs. At various points along the river, logging booms are maintained to facilitate the sorting and handling of the logs.

The following list is a summary of the booming grounds along the Ottawa River (Ottawa River Engineering Board, 1965).

Lake Timiskaming

- Des Quinze boom - a holding boom at the head of Lake Timiskaming.
- White River boom - a holding boom at the mouth of the White River.
- Matabitchuan River boom - a holding boom at the mouth of the Matabitchuan River.
- Opimika boom - a reserve boom about six miles long above the Town of Temiscaming.

Timiskaming Dam to Des Joachims Dam

- A holding boom immediately below Timiskaming Dam.
- A holding boom immediately above Otto Holden Dam.
- A holding boom immediately below Otto Holden Dam.
- A holding boom at the mouth of the Dumoine River.
- A holding boom immediately above Des Joachims Dam.

Des Joachims Dam to Pembroke

- Des Joachims boom - a holding boom three miles below Des Joachims, P.Q.
- Fort William boom - a sorting boom where logs are sorted for delivery to Pembroke.
- A holding boom at the mouth of the Petawawa River.

Pembroke to Bryson Dam

- A holding boom at Chapeau Village.
- Mellons boom - a holding boom 3 miles below Waltham.
- A holding boom at the mouth of the Coulonge River.
- A holding boom immediately above the Bryson Dam.

Bryson Dam to Ottawa

- A holding boom immediately above the Chenaux Dam.
- Chenaux boom - a sorting boom downstream from the Chenaux Dam where logs are sorted for delivery to Braeside.
- Quyon boom - a holding boom below the Des Chats Falls Dam.
- Thomson Bay boom - a holding boom below Deschenes Rapids.
- Chaudiere boom - a boom immediately above Chaudiere Ring Dam.

Below Ottawa

- A holding boom at Fournier Bay on the Ottawa River above the mouth of the Gatineau River.
- A holding boom at the mouth of the Rouge River.

In addition, there are many glancing booms along the river to guide the logs into the proper channels in areas where logs are driven loose instead of being towed.

Log chutes are used to by-pass the structures at most power plants. Where log chutes are not an integral part of a structure, the logs are flushed through spillway gates.

Dredging

The Canada Department of Public Works undertakes channel improvement dredging on the Ottawa River. The federal government has a cost sharing agreement under the Marina Policy whereby the Department of Public Works shares the cost of channel improvement dredging in and around marinas. Also, this department is responsible for the removal of abandoned timber cribs from the river if they pose a navigational hazard. This work usually consists of disposing of all timber from the crib on land and dumping rock ballast in deep water.

Commercial dredging for sand is presently licensed by the Ontario Department of Mines at one location downstream from Ottawa at Petrie Island. The company, D. Grandmaitre Ltd., removes sand from a private river waterlot adjacent to Petrie Island using suction dredges.

6. Fish, Aquatic Life and Wildlife

Sport Fishing

The many lakes and rivers within the basin support a wide variety of fish species, important sport fish species being well represented throughout. Warm-water species are common to most rivers and lakes while cold-water species are found in many headwater streams and in the deep lakes which predominate in the Precambrian Shield Region.

The Ottawa River supports primarily warm-water species with the exception of whitefish, herring, and lake trout in Lake Timiskaming. Species diversity is great and productivity very high particularly in the lower sections. The latter is probably attributable to the more fertile soils of basins tributary to the lower river.

Sport fish species of greatest importance include northern pike, walleye, largemouth and smallmouth bass and yellow perch; a variety of panfish and coarse fish are also taken. A 1969 creel census report published by the Kemptville District of the Ontario Department of Lands and Forests, listed the following sport fish and other species for the lower Ottawa River:

Sport Fish

Northern Pike	-	<i>Esox lucius</i>
Maskinonge	-	<i>E. masquinongy</i>
Smallmouth bass	-	<i>Micropterus dolomieu</i>
Largemouth bass	-	<i>M. salmoides</i>
Black Crappie	-	<i>Pomoxis nigramaculatus</i>
Walleye	-	<i>Stizostedion vitreum</i>
Sauger	-	<i>S. canadense</i>
Yellow Perch	-	<i>Perca flavescens</i>

Other Species

Sturgeon	-	<i>Acipenser fulvescens</i>
Brown Bullhead	-	<i>Ictalurus nebulosus</i>
Carp	-	<i>Cyprinus carpio</i>
American Eel	-	<i>Anguilla rostrata</i>
Pumpkinseed	-	<i>Lepomis gibbosus</i>
Rock Bass	-	<i>Ambloplites rupestris</i>
Mooneye	-	<i>Hiodon tergisus</i>
River Quillback	-	<i>Carpionodes cyprinus</i>
Silver Lamprey	-	<i>Ichthyomyzon unicuspis</i>
Minnows	-	Cyprinidae

Very little information of a definitive nature is available on the magnitude of the sport fishery on the river. Active fish management programs are carried out by agencies of the Ontario and Quebec governments. Since 1921, the Ontario Department of Lands and Forests has continued a stocking program of the lower river which has included plantings of walleye, smallmouth bass and largemouth bass.

A recent census of summer angling activity carried out by the same department in the lower Ottawa River between Rockland and Hawkesbury revealed that during a period of 210 hours on 42 days from June 26 to September 25, 1969, a total of 386 anglers fished for 584 hours and caught 1,040 fish for an average of 1.78 fish per angler hour, an excellent rate of return. Summer sport fishing is probably greatest in the area from Ottawa-Hull upstream to Allumette Lake in areas of the highest cottage density. Information on cottager angling pressure has been presented previously in this appendix in Section 2, Recreation and Aesthetics.

Winter ice fishing is also an important segment of the sport fishery of the lower river, particularly on Lake of Two Mountains (Table E-8). The latter area receives approximately 64 per cent of the winter angling pressure and accounts for a majority of the catch taken from six major ice fishing areas within the Montreal district (1965-1966 data).

TABLE E-8

Ice Fishing Effort and Catch for Quebec Waters
of the Lower Ottawa River in 1965-66

LOCATION	ANGLERS	MAN-HOURS	CATCH					Total
			Perch	Pike	Walleye	Ling	Others	
Papineauville and Pte-au-Chene	57	312	157	43	14	3	-	217
Lake of Two Mountains	8,134	36,540	67,011	2,189	200	701	54	70,155
TOTALS	8,241	36,852	67,168	2,232	214	704	54	70,372
Percent of total for the Montreal District	56.5	64.0	54.2	74.5	38.6	68.3	25.6	54.7

SOURCE: Information derived from a creel census on 33 days from December 11 to March 26 provided by the Ministere du Tourism de la Chasse, et de la Peche, Service de la Faune, District de Montreal.

Commercial Fishing

The commercial fisheries on the river are described in Tables E-9 and E-10 in terms of number of fishermen, fixed capital and poundage, and value of catch for 1968. Data given for Quebec include those for commercial fisheries of tributary basins within the counties listed and for the Ottawa River. Data for Ontario pertains only to the Ottawa River. Of the 158 commercial fishermen in Quebec, 19 hold licenses on the Ottawa River, 13 of which are located on the lower river downstream from Hull, and six on the upper river upstream from Hull. The total number of commercial fishermen is 40 for the lower river and nine for the upper river.

Commercial fish species in order of importance based on poundage are bullhead, bait minnows, sturgeon, catfish, whitefish, suckers, sunfish, herring, eel, carp and perch. In terms of dollar value, bait minnows, bullheads and sturgeon are most important.

Waterfowl

The many lakes and rivers as well as smaller streams and beaver ponds throughout the basin provide important breeding habitat, centrally located in the northeastern range, for a variety of waterfowl species. The Ottawa River contains numerous expanses of marshlands along its borders particularly in the lower reaches. These areas are excellent breeding grounds for waterfowl, in addition to being important holding areas and staging grounds for migrating waterfowl. With regard to the latter, the river is an important flyway for migrating waterfowl linking breeding grounds of the Hudson Bay lowlands and lakes of northern Ontario and Quebec to the Atlantic Flyway. Waterfowl hunting on the Ottawa River is important to local sportsmen; duck hunting clubs are located on the lower river near the communities of Masson and Plaisance.

TABLE E-9

Number of fishermen and fixed capital for commercial fisheries of the Ottawa River and tributary basins within Quebec counties bordering the Ottawa River in 1968

LOCALITY	FIXED CAPITAL \$				COMMERCIAL FISHERMEN
	Craft	Gear	Shore Instal- lations	Total	
QUEBEC (by county)					
Argenteuil	1,428	417	2,525	4,370	12
Deux Montagnes	3,165	1,795	385	5,345	10
Gatineau	6,090	1,925		8,015	38
Papineau	5,865	4,680	1,810	12,355	34
Pontiac	3,625	8,758	700	13,083	16
Rouyn-Noranda	755	480		1,235	11
Timiskaming	6,855	4,632	400	11,887	29
Vaudreuil	1,245	140		1,385	8
TOTAL	29,028	22,827	5,820	57,675	158
ONTARIO					
Carillon Dam to Chaudiere					
Dam	3,055	5,450	6,194	14,699	27
Upstream from Chaudiere					
Dam	2,900	4,240	1,760	8,900	3
TOTAL	5,955	9,690	7,954	23,599	30
SOURCES: 1) Ontario Department of Lands and Forests					
2) Pêche Commerciale, 1968.					
Bureau de la Statistique du Quebec					
Ministere de l'Industrie et du Commerce					

TABLE E-10

Harvest and value of commercial fish species
for the Ottawa River and Tributary Basins within
Quebec counties bordering the Ottawa River in 1968

Location	Harvest (pounds)	Value (dollars)
QUEBEC (by county)		
Argenteuil	61,266	12,394
Deux Montagnes	45,080	22,440
Gatineau	11,507	8,336
Papineau	72,856	16,305
Pontiac	28,020	10,976
Rouyn-Noranda	4,363	3,927
Timiscaming	9,395	10,071
Vaudreuil	4,803	2,844
ONTARIO		
Carillon Dam to		
Chaudiere Dam	123,556	24,608
Upstream from		
Chaudiere Dam	34,795	6,542
TOTAL	395,641	118,443

SOURCES: 1) Ontario Department of Lands and Forests
2) Peche Commerciale, 1968
Bureau de la Statistique du Quebec
Ministere de l'Industrie et du Commerce

APPENDIX F

WATER QUALITY EVALUATIONS

The discussion of water quality presented in Section 3.3 is a summation of information contained in this appendix. In order to assist in the presentation of the large volume of data that is available and in the setting of water quality standards, the river has been sub-divided into six zones. These zones are described in detail in Section 4.1 of the text and illustrated in the figures of Appendix G. The physical, chemical, biological and bacteriological aspects of water quality, as well as a section dealing specifically with the oxygen resources, are presented and discussed for five of the zones.

Much of the data on the physical and chemical characteristics of the water were collected during the regular monitoring program described in Section 5.1 of Chapter 5. These monthly samples were taken from mid-river in order to be indicative of the overall quality of the river, as opposed to local conditions at the shorelines. Although most of the monitoring data are presented as averages, the range of results obtained is presented in some cases. Downstream trends are noted where indicated by the results.

An examination of biological characteristics was undertaken extensively throughout the river and intensively below points of major waste discharges. Biological parameters are useful in that even slight changes in physical and chemical aspects of water quality are usually manifested in detectable alterations in the composition and balance of biotic communities. In addition to indicating areas of water quality degradation, adverse changes in biotic communities provide direct evidence of pollution damage to the river. In this study, emphasis was placed on an examination of benthic macroinvertebrate communities. These are comprised of organisms having a wide range in tolerance to various contaminants and a life history sufficiently long to permit detection of adverse changes in water quality (even of short duration) over a considerable period of time prior to sampling. Moreover, these organisms form an important segment of the food resource for fish, waterfowl and other aquatic life.

During the past three years, intensive seventy-two hour surveys have been conducted in three of the zones to obtain the data necessary to evaluate the capacity of the river to receive organic materials without impairment of water quality. Although detailed data are presented in Volume II, summaries of these

results as they apply to the oxygen resources of each zone are included in this appendix.

Bacteriological data collected by the Ontario Department of Health were used to supplement data collected over the duration of the study during special surveys and as a part of the regular monitoring program. Although too few samples were collected to compare the results with the Water Quality Standards (see Chapter 4), the findings are sufficient to indicate the general degree of bacterial contamination.

The basic data, upon which these summaries are based, are tabulated along with a description of methodology in Volume II of this report.

ZONE 5

Zone 5 is that part of the Ottawa River known as Lake Timiskaming (RM 372.4 to RM 440.2) extending upstream from the Canada Public Works Dam at the Town of Temiskaming (see Figure G.1).

No regular monitoring of water quality is carried out in Zone 5 except at the downstream boundary with Zone 4. Much of the data reported in the physical and chemical sections below are based on samples taken at the Timiskaming Dam (RM 372.4). It should be recognized that this may not be completely representative of the whole zone and could be partially influenced by the nearby logging operation on the Quebec side of the dam. Where enough samples have been collected and where there is a marked difference in results between monitoring stations on the dam, the parameter values for the Ontario side of the dam have been reported. Otherwise, average values for the whole dam are given.

Thermal profiles, sediment characteristics, concentrations of mercury in sediments and fish flesh, and bottom fauna communities were examined only in lower Lake Timiskaming.

i) Physical Characteristics

Total solids concentrations ranged between 45 and 80 mg/l with an average of 58 mg/l; the suspended solids level averaged 4.7 mg/l. Turbidity levels ranged between 4 and 8.5 Jackson units with an average level of 6.1 Jackson units. Secchi disc readings varied between 6.5 and 7.5 feet.

In July 1969 waters of Lake Timiskaming were found to be thermally stratified with a surface temperature of 21°C and a

bottom temperature of 8°C at 130 feet, the deepest point measured. In the winter, the lake freezes over.

Bottom sediments consisted of natural clay deposits with varying amounts of organic silt and finely divided woody detritus of natural origin.

A record of water levels in the forebay of the Timiskaming Dam serves as an indication of the water level fluctuations occurring in the zone. Yearly variation amounts to about 12 feet. Water levels are kept fairly steady during the summer months to facilitate navigation. The lowest water levels occur in early spring when reservoirs along the river are drawn down prior to the spring freshet.

ii) Chemical Aspects

The dissolved oxygen levels recorded at the dam range from a low of 8.0 mg/l to a high of 12.6 mg/l and the BOD has been found to range from 0.3 to 1.5 mg/l with an average of 0.7 mg/l.

The average nutrient concentrations were as follows: 0.02 mg/l total phosphorus (as P), 0.0 mg/l soluble phosphorus (as P), 0.07 mg/l NH₃ (as N), 0.33 mg/l total kjeldahl (as N), 0.0 mg/l nitrite (as N), and 0.14 mg/l nitrate (as N).

A summary of the results for the remaining chemical analyses performed on water samples taken on both a regular or annual basis is given in the following table.

Chemical Parameters	Averages mg/l	Ranges mg/l
Total Hardness (as CaCO ₃)	33	32 - 34
Total Alkalinity (as CaCO ₃)	20	19 - 21
Total Iron (as Fe)	.42	.40 - .45
COD	13	10 - 15
pH*		7.2 - 7.7

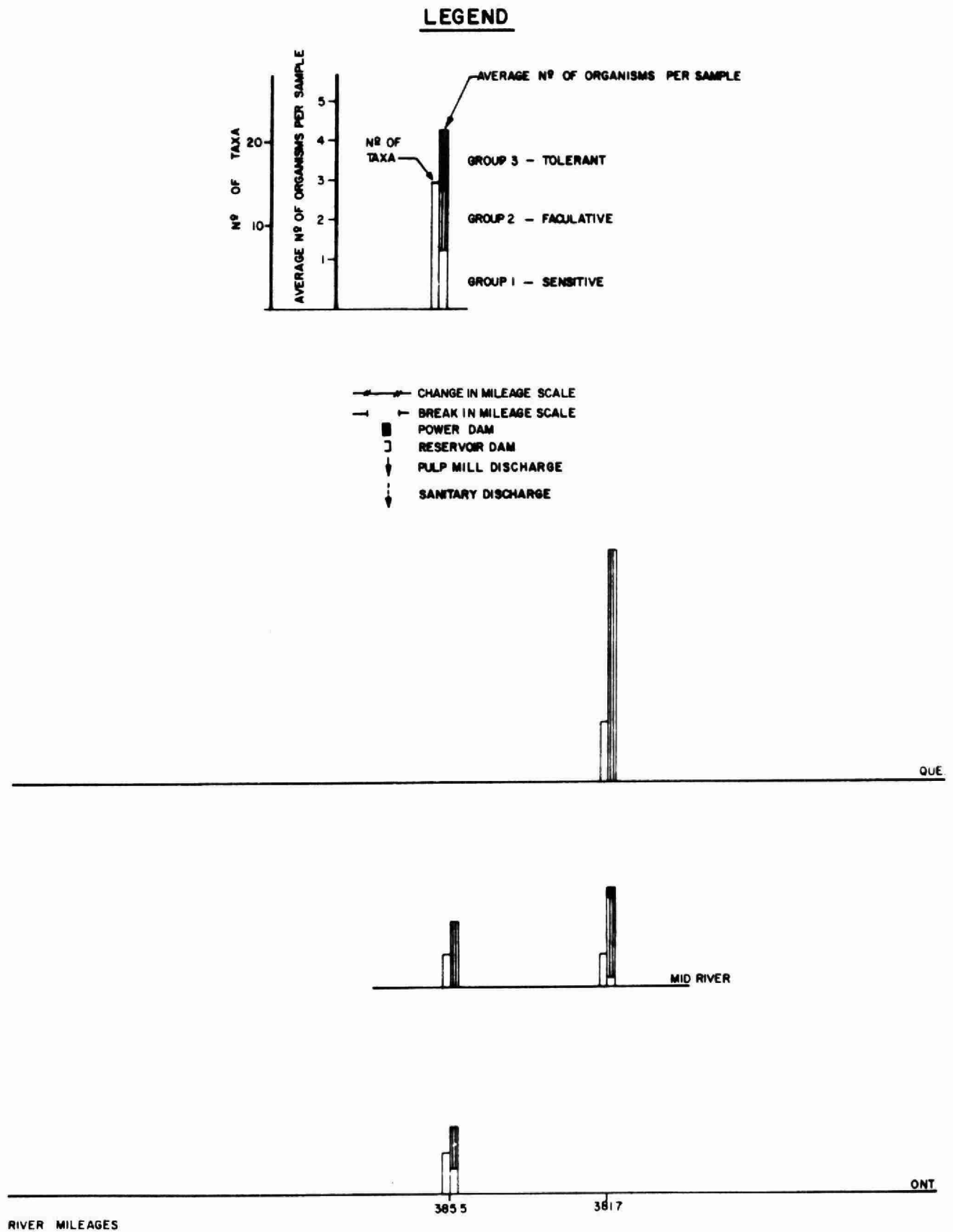
* pH reported in units

No significant amounts of arsenic, chromium, cyanide, or lead were measured.

iii) Biological Characteristics

Bottom fauna communities were examined at four stations in lower Lake Timiskaming at depths of 42, 74, 78 and 130 feet (see Figure F-1). Communities at these sites were diverse and

FIG. F-1 COMPOSITION AND ABUNDANCE
OF BOTTOM FAUNA COMMUNITIES AT
SELECTED STATIONS IN ZONE 5



characterized by an extremely small biomass. Communities were comprised of a total of ten taxa with an average of five taxa per station and total organisms per square foot varied between 9.5 and 2.4 at depths of 45 feet and 130 feet respectively. The mayfly, *Hexagenia* sp., which is sensitive to even moderately low levels of dissolved oxygen, was common to most stations and was found at the 130 foot depth.

iv) Oxygen Resources

Three communities discharge municipal wastewater to Lake Timiskaming. However, no significant demand on the dissolved oxygen resources of this zone presently exists, either from wastewater loadings or benthic sludge deposits. Dissolved oxygen levels remain above 6.0 mg/l at all times permitting the maintenance of a cold water fishery in the lake.

ZONE 4

Zone 4 extends from the Ontario Hydro Des Joachims generating station (RM 282.0) to the Canada Public Works Dam at the Town of Temiskaming (RM 372.4) (see Figure G.2).

i) Physical Characteristics

The depth of the Ottawa River between Lake Timiskaming and the Des Joachims power dam varies in depth up to 150 to 200 feet. In several areas, depths of several hundred feet occur.

From the regular monitoring data, total solids levels were found to range from 45 to 85 mg/l with an average for the whole zone at about 60 mg/l. Levels of suspended solids varied widely from 5 to 25 mg/l, with an average for the zone of about 7 mg/l. The average turbidity ranged from 5 to 11 Jackson units with extremes of 3 and 25 noted. Limited data on colour indicated levels ranging from 30 to 35 Platinum-Cobalt units. No significant seasonal or downstream trend was found in the above parameters.

Over the year the river temperature ranged from 0°C in the winter months to a high of about 20°C in the summer. Surface water temperatures in August varied between 18 and 21°C. Temperatures measured at two stations upstream from the Otto Holden generating station decreased from 20.5°C at the surface to approximately 8°C at a depth of 135 feet. The sharpest decline from 18.3°C to 12.5°C occurred between the 50 and 75 foot depths indicating a thermal stratification with a poorly defined thermocline.

Extensive bottom deposits consisting primarily of pulp mill solids waste were found downstream from the outfall of the Kipawa mill of the Canadian International Paper Company (RM 372.1) (see Figure F-2). At 23 of 27 stations in the 6 mile section of river below the mill outfall, natural river substrates were completely blanketed by varying depths of waste solids, including bark, coarse and fine wood chips, and fibre. Increased current velocities prevented deposition of solids at the remaining four stations. Bottom deposits at stations sampled downstream from a point 10 miles below the mill outfall consisted entirely (on the basis of visual observation) of natural deposits, including mostly organic silt and clay-silt mixed with organic detritus. The section of river from 6 miles to 10 miles below Lake Timiskaming (referred to as Seven League Lake) is a widening of the river which is considerably deeper (several hundred feet) than adjacent upstream and downstream sections. The observed distribution of sludge beds would indicate that waste solids, which are probably only temporarily deposited in the 6 mile section of river downstream from Lake Timiskaming, are ultimately accumulating in the Seven League Lake. The above was further substantiated by visual observation of the distribution of gas bubbles resulting from benthic anaerobic decomposition and mats of sludge which are periodically resuspended by these gases. Indications of sludge deposits persisted downstream to a point in Seven League Lake approximately 8.0 miles below Lake Timiskaming. During summer periods, floating sludge mats are consistently present on this portion of the river.

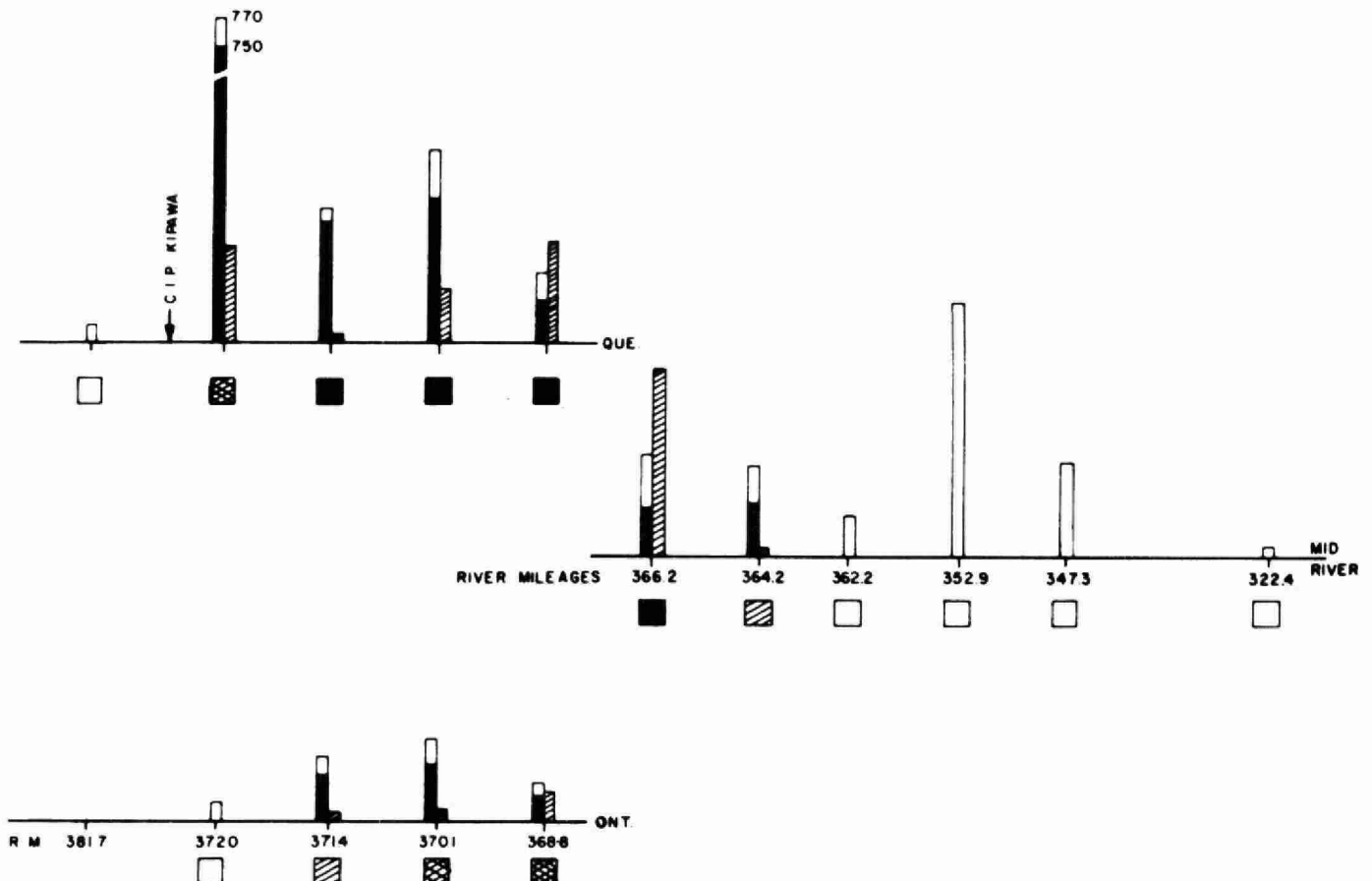
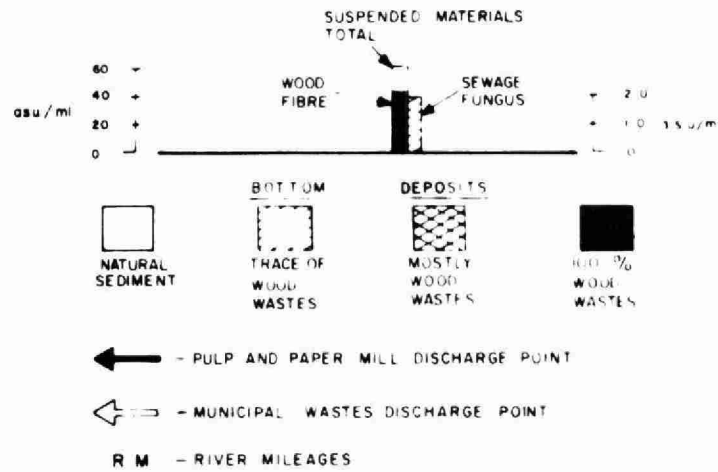
Suspended fibre concentration (see Figure F-2) at the Timiskaming Dam (RM 372.4) was 0.3 asu/ml. By comparison, concentrations downstream from the Canadian International Paper Company outfall reached a high of 751 asu/ml (RM 372.0) decreasing downstream to an average of 122 asu/ml (RM 370.1) and 15.4 asu/ml (RM 368.8) and increasing to 39.6 asu/ml (probably from resuspension of previously deposited material) at RM 364.2. At RM 362.2, approximately ten miles downstream from the Kipawa mill outfall, the concentration had decreased to that observed upstream of the outfall and levels remained low downstream throughout Holden Lake (0.6 asu/ml at RM 322.4).

Secchi disc readings, recorded for the upper portion of the zone extending approximately six miles below Timiskaming, varied between 5 and 6 feet. In the lower portion of the zone (Holden Lake) readings were similar to those observed for lower Lake Timiskaming (6 to 7 feet).

The water levels in this zone have an annual fluctuation of about eight feet, the lowest levels occurring prior to the spring freshet. However, during the summer months the levels do

FIG. F-2 CONCENTRATIONS (a.s.u./ml) OF TOTAL SUSPENDED MATERIAL, WOOD FIBRE AND SEWAGE FUNGUS AND COMPOSITION OF BOTTOM DEPOSITS AT SELECTED STATIONS IN ZONE 4

LEGEND



not vary more than two feet except the section of the river downstream from the Otto Holden Dam (RM 340.9).

ii) Chemical Characteristics

The average annual dissolved oxygen levels in Zone 4 varied between 9.0 and 10 mg/l from year to year. These levels have periodically reached a low of 4.8 to 5.0 mg/l in the summer months. At the upstream boundary of the zone, the BOD averaged about 0.7 mg/l with an average, for the remainder of the zone, of 1.7 mg/l (ranging from 0.4 to 3.5 mg/l).

River samples have been analyzed for phosphorus and nitrogen on a regular basis. The total phosphorus levels throughout the zone averaged 0.03 mg/l (as P), with a maximum of 0.14 mg/l and minimum of 0.0 mg/l. This constituted an average increase of 0.01 mg/l over the concentration from the upstream water. The levels of soluble phosphorus ranged from 0.0 to 0.06 mg/l (as P) with an average of 0.01 mg/l (as P) except during 1970 when the concentration was closer to zero. The free ammonia (NH₃) concentrations (as N) ranged from 0.01 to 0.24 mg/l with an average of 0.09 mg/l. This average has been increasing in the past few years. Similarly, the average concentration of total kjeldahl (as N) has increased from about 0.40 mg/l in 1968 to about 0.55 mg/l (as N) in 1970. While the nitrite levels were generally low, the nitrate levels (as N) ranged from 0.01 to 0.33 mg/l with an average of 0.12 mg/l. These nitrate concentrations were lower on the whole than those in the water entering the zone.

The average levels of other parameters measured on a regular basis were: 30 to 40 mg/l total hardness (as CaCO₃), 22 mg/l total alkalinity (as CaCO₃), 0.45 mg/l total iron (as Fe), and a conductivity of 70 micromhos.

The average results from other parameters measured periodically are listed in the following table.

Parameter	Avg. Concentration
Chemical oxygen demand	30 mg/l
Phenol	0.003 mg/l
Sulphate	10 mg/l
Lead	0.15 mg/l
Zinc	0.04 mg/l

No significant amounts of copper, chromium, or cyanide were measured.

iii) Bacteriological Characteristics

Water at the Timiskaming Dam (RM 372.4) on the Ottawa River was not significantly contaminated in 1968 and 1969 except for some excessive enterococci levels.

Timiskaming Dam

	Total Coliform /100 ml	Fecal Coliform /100 ml	Entero- coccus /100 ml	Plate Count /100 ml
1968	147 (15)	13 (10)	39 (7)	3.0×10^4 (3)
1969	49 (9)	7 (8)	33 (8)	2.0×10^4 (2)
Numbers indicated are geometric means () number of samples				

Comparable conditions were found further downstream, with signs of improvement downstream from Otto Holden Dam (RM 340.9). At Des Joachims (RM 282), the river had relatively low bacterial numbers (with the exception of enterococci in 1968).

Des Joachims (RM 282)

	Total Coliform /100 ml	Fecal Coliform /100 ml	Entro- coccus /100 ml
1968	10 (14)	3 (8)	79 (10)
1969	3 (7)	2 (7)	2 (7)
Numbers indicated are geometric means () number of samples			

The plate counts of organisms in this reach of the Ottawa River ranged from 20,000/100 ml at Temiscaming dam in 1969 to 101,000/100 ml at Otto Holden Dam in 1968.

Tributaries to the Ottawa River were characterized by varying degrees of contamination. Bacterial counts in Gordon Creek, downstream from the point of discharge of untreated sewage from the Town of Temiscaming, were excessive in 1969. Bacteriological data for the Big Jocko River usually indicated safe conditions for recreational use. Except for enterococci, the Mattawa River and the creek at Deux Riviere were also acceptable.

The number of sulphate-reducers (*Desulfovibrio*) in the surface waters increased from 20/100 ml at the Temiscaming Dam to 70/100 ml just below the outfall of the Canadian International Paper Company Kipawa mill. Similarly, a rise was detected in sulphur-oxidizers (*Thiobacillus*) from less than 3/100 ml above the mill to 20/100 ml below the mill. The number of *Thiobacillus* in the effluent were lower than in the river water suggesting that multiplication occurred in the river below the discharge.

Both the sulphur-oxidizers and reducers in the water fell off by Wilson's Landing (RM 345.1). The number of both Thiobacillus and Desulfovibrio in the sediment were very high below the outfall of the Kipawa mill, with the concentrations of sulphur-oxidizers in the sediments dropping off by Mile 362.3 and the concentration of sulphate-reducers by the Otto Holden Dam.

iv) Biological Characteristics

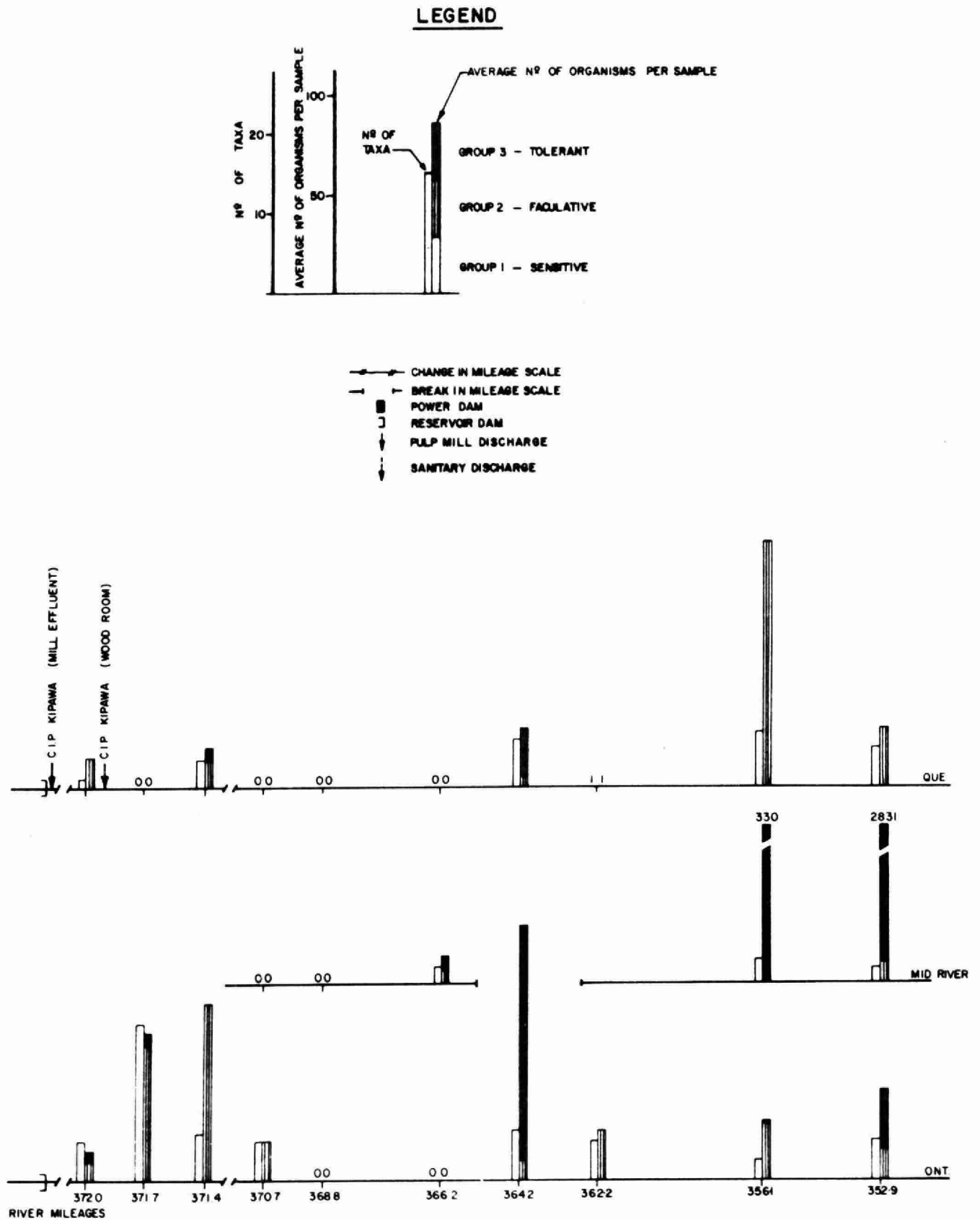
Changes in the characteristics of bottom fauna communities further illustrate the adverse effects of waste discharges from the Kipawa mill at Temiskaming on this zone of the river (see Figure F-3). At control stations upstream from the mill outfall, communities consisted of an average of 7.5 taxa and 77 organisms per square foot. By comparison, no bottom organisms were found at 14 of 22 stations in the six miles of river below the outfall. At the remaining eight stations in this six-mile section, communities were comprised entirely of pollution-tolerant sludgeworms and midges with an average of two taxa per sample and 27 organisms per square foot.

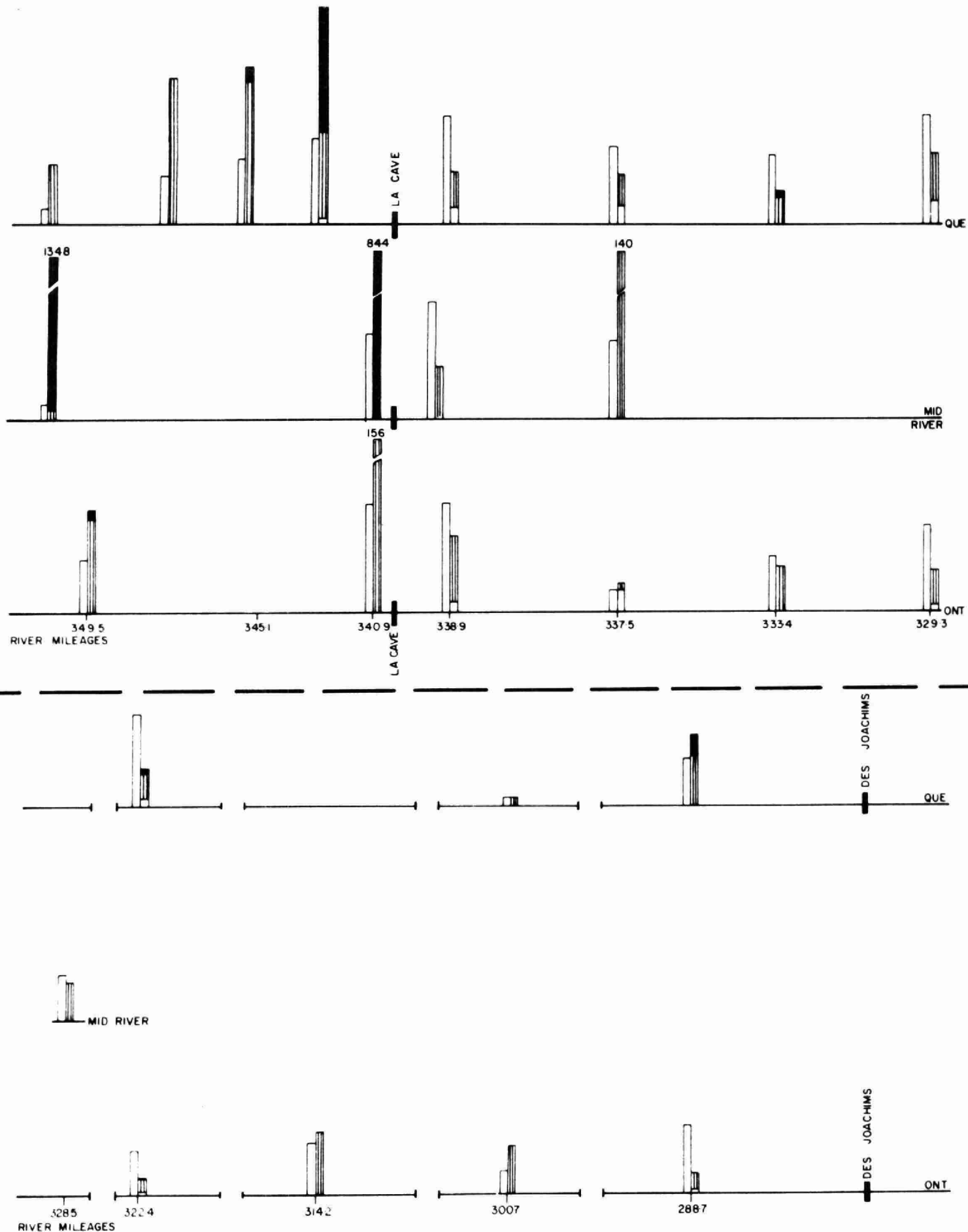
Further downstream, from RM 366.2 to RM 362.2 (Seven League Lake), natural sediment deposits, largely silt, supported a population of only tubificed worms at an increased density of 433 per square foot at a depth of 87 feet and organisms were essentially absent from three stations at depths of 111 and 147 feet.

Downstream from Seven League Lake, 9.8 to 27.9 miles below Lake Timiskaming, communities at depths between 30 and 80 feet consisted of an average of 4.8 taxa and 91 organisms per square foot, increasing to 12 taxa and a density of 235 per square foot at a point 31.1 miles (near La Cave) below Lake Timiskaming. Sensitive species of Group 1 organisms (caddisflies) re-appeared at approximately 22.5 miles below Timiskaming. Throughout this section, at depths ranging from 125 to 165 feet, communities consisted of an average of three taxa, chiefly tolerant worms and midges, and densities increased to 4,813 per square foot and decreased to 1,435 per square foot at distances of 19.1 and 31.1 miles, respectively, below Timiskaming.

Below the Otto Holden Dam and throughout Holden Lake, sensitive Group 1 organisms including leptocerid caddisflies and the highly sensitive mayfly, Hexagenia sp., were common to most stations. At one station approximately seven miles below Otto Holden Dam, sensitive species were absent and a definite shift to more tolerant forms was noted. At 19 stations in this section of the river in depths ranging to 83 feet, the average number of

FIG. F-3 COMPOSITION AND ABUNDANCE
OF BOTTOM FAUNA COMMUNITIES AT
SELECTED STATIONS IN ZONE 4





taxa and density of organisms per station were 8.4 and 49 respectively.

The almost total decimation of bottom fauna in the six miles of river below Timiskaming was related more to the effect of sludge deposition than to adverse water quality per se. For example, artificial rock substrate samplers suspended over sludge beds were colonized by a good variety of tolerant and semi-tolerant organisms that were not present in bottom sludge deposits, probably because of the combined effects of the unstable, shifting substrate, and oxygen depletion or toxicity associated with by-products of anaerobic decomposition within the sludge deposits. The effect attributable to water quality over the bottom is seen by the absence of sensitive mayflies and caddisflies on suspended substrates downstream of the mill effluent discharge as compared with the predominance of these species found on similar substrates upstream of the discharge.

A gradual improvement in the diversity of fauna and the temporary increase in numbers of organisms and subsequent decrease in the section of river extending downstream from Seven League Lake to La Cave (32 miles below Lake Timiskaming) indicated a considerable degree of recovery from the above noted effects, although species sensitive to low levels of dissolved oxygen were sparse in shallow depths and absent at greater depths. Mayflies (*Hexagenia* sp.) and other sensitive species were found below the Otto Holden generating station (probably because of re-aeration) but were absent at subsequent downstream stations. At RM 229.3 (approximately 43 miles below Lake Timiskaming) these forms re-occurred and persisted downstream indicating complete recovery at this point.

v) Oxygen Resources

An intensive wastewater assimilation survey was undertaken along this reach of the river during August, 1969. Significant benthic sludge deposits extending approximately six miles downstream from the Town of Temiskaming (RM 372.3), and industrial waste discharges from the Kipawa Mill of the Canadian International Paper Company exerted an extensive demand on the dissolved oxygen resources of the river resulting in a minimum dissolved oxygen level of about 5.0 mg/l near Mattawa (RM 336.3) (streamflow and temperature averaged 20,300 cfs and 20°C respectively). It is estimated that the present day waste loadings and sludge deposits would deplete the dissolved oxygen level in the zone to a minimum of about 2.0 mg/l under critical conditions of 10,000 cfs streamflow and a 25°C water temperature. The reservoir created behind the Ontario Hydro Otto Holden generating station near Mattawa has an extremely low reaeration rate which is partly responsible for the large dissolved oxygen

sag downstream from Lake Timiskaming. This oxygen depletion does not recover to normal levels until after the Des Joachims generating station 90 miles downstream from the Kipawa mill.

ZONE 3

Zone 3 extends from the Chaudiere Dam at the cities of Ottawa-Hull (RM 129.9) to the Ontario Hydro Des Joachims generating station (RM 282.0) (see Figure G.3). Because of the two nuclear installations in this zone, a special section dealing with the radiological aspects of water quality is included here.

i) Physical Characteristics

The physical data collected during the regular monitoring program are summarized in the following paragraph.

There was a trend to higher total solids concentrations moving downstream through the zone. The levels averaged between 50 and 60 mg/l upstream from the Chenaux Dam (RM 188.6), increasing to between 60 and 80 mg/l at Des Chats Falls (RM 163.6) and between 77 and 85 mg/l at Britannia Waterworks (RM 133.8). Extreme values of 120 and 40 mg/l were found in this zone. There does not appear to be a significant trend in suspended solids concentration, levels ranging widely from 2 to 40 mg/l with an average of about 7 mg/l. For turbidity, the levels varied from station to station and from year to year, with averages between 4.3 and 9.0 Jackson Units. A few extreme values of 20 and 30 Jackson units have been measured at several of the stations within the zone. From the limited colour data that were collected the levels appear to be within 24 to 36 Platinum Cobalt units.

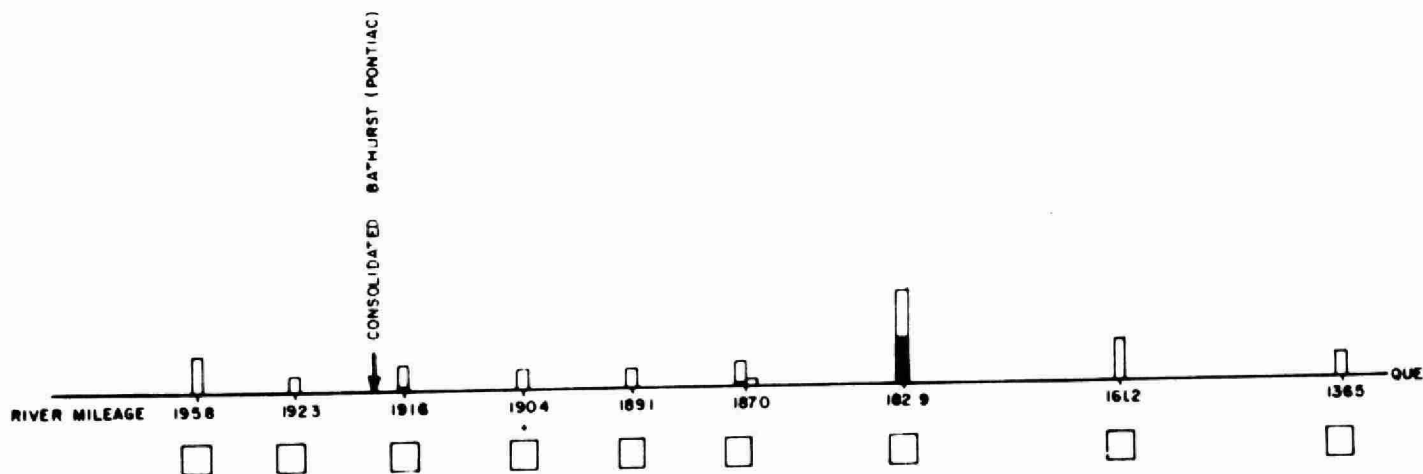
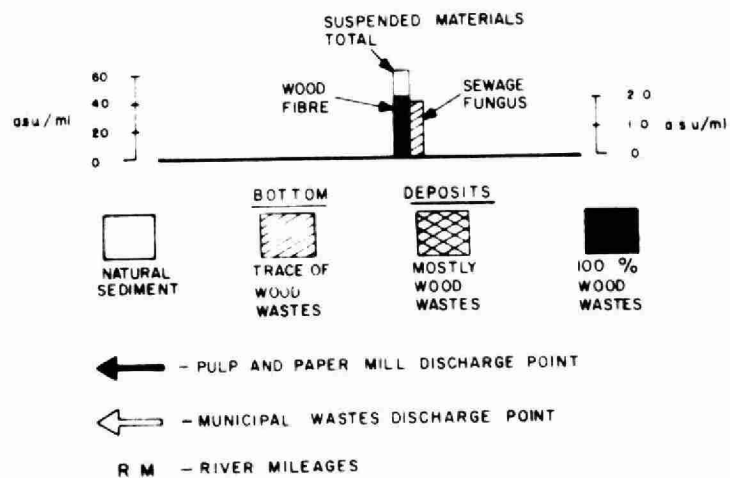
During special studies, physical data were collected at a total of 41 stations along the river in this zone.

Average surface temperature in May, 1969 was 9.6°C for the zone exclusive of the upper portion of Allumette Lake where the average temperature was 11.7°C at two ranges (RM 270.4 and RM 255.8). Surface temperatures in July and August averaged 21.4°C. During the winter the river freezes over.

In May, the river was nearly homothermous (surface and bottom waters respectively 9.0°C and 8.4°C at a depth of 90 feet at one station in Lake Deschenes). In late July, a surface to bottom temperature variation of 22.2°C and 5.3°C, respectively, was observed at one station in Lake Rocher-Fendu. The greatest temperature decrease of approximately 0.15°C per foot occurred between 85 and 125 feet. In another study thermal stratification

FIG. F-4 CONCENTRATIONS (a.s.u./ml.) OF TOTAL SUSPENDED MATERIAL, WOOD FIBRE AND SEWAGE FUNGUS AND COMPOSITION OF BOTTOM DEPOSITS AT SELECTED STATIONS IN ZONE 3

LEGEND



in August was not detected in Allumette Lake (Ontario Department of Lands and Forests, pers. comm.).

Secchi disc readings in May averaged 5.3 feet for Allumette, Chats and Deschenes lakes and in July averaged 6.2 in Lake Rocher-Fendu and 4.9 in lower Lake Deschenes.

River sediments at most stations consisted of organic silt with varying amounts of clay, fine sand and organic detritus. Accumulations of bark deposits which completely blanketed the bottom were observed in the vicinity of the log chute and booming grounds below the Des Chats Falls Dam. Although not investigated, similar conditions probably exist to some extent below upstream dams at Chenaux, Bryson and Des Joachims. No evidence of bark or wood waste accumulations was found downstream of the outfall from the Consolidated Bathurst (Pontiac) mill (RM 188.7).

Below the Consolidated Bathurst outfall, suspended wood fibre concentrations increased slightly to 2.2 asu/ml from 0.1 asu/ml at control sites and decreased to 0.1 asu/ml at the Chenaux Dam (3.5 miles downstream from the outfall). Immediately below the dam, the concentration increased to 2.0 asu/ml and further downstream, at one station in upper Lake Des Chats (RM 182.9), the concentration rose to a very high level of 54.5 asu/ml. The former increase in concentration can be attributed to the effect of passage of logs through the chute at the Chenaux Dam. The high level noted at RM 182.9 can only be related to the effect of log driving activities associated with the extensive log booming grounds located approximately one mile upstream from this point. Although suspended wood fibre concentrations were not examined elsewhere in this zone, the above observation would suggest that elevated levels probably occur, at least locally, in other areas where log driving activity is intensive.

Water levels are recorded daily at five different locations within Zone 3, the average annual fluctuation for the whole zone being about seven feet. The greatest variation usually occurs in the months of April and May; level fluctuations are kept within a foot during the summer.

ii) Chemical Characteristics

The dissolved oxygen concentrations in Zone 3 showed no definite trend downstream. The lowest level recorded for the zone was 6.0 mg/l at the Chenaux Dam (RM 188.6) and the Des Joachims Dam (RM 282.0). Similarly, there was no apparent downstream trend for BOD concentrations. The overall average was about 1.0 mg/l with a usual range of 0.7 to 1.8 mg/l. On occasion a few values of 2.5 mg/l BOD were recorded.

The nutrient levels in terms of phosphorus and nitrogen were fairly consistent throughout the zone. Total phosphorus concentration (as P) averaged between 0.02 and 0.03 mg/l with a range of 0.0 to 0.09 mg/l. The soluble form ranged between 0.0 and 0.03 mg/l with an average of .01 mg/l. The ammonia concentration (as N) in the zone varied between the extremes of 0.01 and 0.18 mg/l with the average concentration at about 0.07 mg/l. The average total kjeldahl, measured at the various monitoring stations in the zone, ranged between 0.32 and 0.51 mg/l (as N). There were generally no nitrites found and the nitrates averaged between 0.08 and 0.15 mg/l (as N).

Many of the other chemical parameters measured on a regular basis showed a downstream trend. The conductivity averaged about 70 micromhos from Des Joachims to the Chenaux Dam, increased to an average of 80 micromhos at Des Chats Falls (RM 163.6) and approached an average of about 100 micromhos at the downstream end of the zone. Total hardness (as CaCO₃) showed a similar trend with the average increasing from 30 mg/l to 44 mg/l over the length of the zone. The alkalinities reported for this zone fluctuated widely. For most of the zones, the concentration ranged between 9.0 and 46 mg/l (as CaCO₃) with an average of about 20 mg/l. At the downstream end of the zone the average alkalinity was slightly higher at 25 mg/l. The average concentration of total iron (as Fe) ranged between 0.30 and 0.50 mg/l with the highest concentration reported at Des Chats Falls.

Other chemical parameters showed no apparent trend. In some cases, this may reflect insufficient sampling frequency. The pH ranged between the extremes of 6.8 and 8.3. The maximum and minimum values measured for chemical oxygen demand (COD) were 11 and 49 mg/l; the average for the various stations was between 21 and 28 mg/l. Based on ten samples measured at Pembroke (RM 241.9) and the Chenaux Dam, the average phenol concentration for this area of the zone was between 0.010 and 0.012 mg/l. The average phenol concentration recorded at Britannia was much lower at .005 mg/l. Sulphates have been regularly monitored at two stations, the average concentration being 14 mg/l at Chenaux Dam and 17 mg/l at the Britannia Waterworks. Several samples were analyzed for lead at these two stations. Although many of the analyses showed no lead, a few indicated concentrations as high as .26 and .30 mg/l.

iii) Bacteriological Characteristics

With the exception of high enterococcus levels in 1968, the bacterial quality of the river at the Des Joachims Dam (RM 282) was acceptable. However, during the same year, samples taken at Pembroke indicated bacterial levels that might have violated the proposed water quality standards had enough samples been taken (see Section 4.1).

Location	Year	Total Coli-forms /100 ml	Fecal Coli-forms /100 ml	Enterococcus /100 ml
Pembroke A*	1968	1,630 (7)	523 (6)	57 (6)
	1969	545 (2)	109 (2)	2 (2)
Pembroke B**	1968	291 (9)	147 (7)	37 (8)
Pembroke C***	1968	1,750 (5)	350 (4)	54 (4)
	1969	88 (2)	4 (2)	2 (2)

*A between Allumette Island and Morriston

**B between Cotnam Island and Morriston

***C between Ontario shore and Cotnam Island

Numbers indicated are geometric means () number of samples

At Waltham Station (RM 223.2) the number of enteric bacteria was quite low in 1968. Data collected at Bryson (RM 198.9) supported this finding. Chenaux Dam (RM 188.6) had approximately the same quality as Bryson, with an improvement in 1969 over the 1968 results.

Samples collected in the lower reach of Zone 3 indicated varying concentrations of bacteria. Downstream from Constance Bay (RM 152.8), bacterial contamination exceeded the permissible limits for water-contact recreation. Further downstream, at Shirley's Bay, water quality was generally acceptable for recreational use, however between Shirley's Bay and the Britannia Yacht Club significant bacterial contamination was found. Marked improvement in the bacterial quality of the river was observed one mile further downstream at the Chaudiere Dam (RM 129.9). The following is a summary of bacteriological data at the Chaudiere Bridge.

Chaudiere Bridge

	Total Coliform /100 ml	Fecal Coliform /100 ml	Entero- coccus /100 ml	Plate Count
1968	1,737 (4)	160 (3)	65 (3)	1.0×10^5 (1)
1969	305 (4)	55 (3)	41 (2)	5.5×10^4 (1)
Numbers indicated are geometric means				() number of samples

There are two large bathing beaches on the last seven miles of the Ontario shore of Zone 3, Britannia Beach (RM 136) and Westboro Beach (RM 132.6). Although there has been a history of contamination at these locations, conditions have been improving in recent years due to increased efforts to provide better sewage treatment. In 1970, both beaches were open for water-contact recreational use during most of the summer.

The levels of bacteria in the tributaries entering the river in this zone varied considerably. The Petawawa River (RM 252) was contaminated to a greater extent than the water in the Ottawa River entering the zone. Excessive numbers of bacteria existed in the Muskrat River (RM 241.9), especially in 1968, as indicated in the following table.

Musktrat River

	Total Coliform /100 ml	Fecal Coliform /100 ml	Entero- coccus /100 ml
1968	3,860 (5)	1,100 (4)	703 (4)
1969	1,040 (3)	153 (2)	106 (2)
Numbers indicated are geometric means			() number of samples

The Coulange River (RM 210) was found to have very little bacterial contamination while samples taken from Watts Creek (RM 139.2) which enters Shirley's Bay indicated excessive bacterial content as indicated below.

Watts Creek

	Total Coliform /100 ml	Fecal Coliform /100 ml	Enterococcus /100 ml
1968	22,130 (5)	3,578 (4)	1,218 (4)
1969	1,507 (3)	130 (2)	383 (2)
Numbers indicated are geometric means () number of samples			

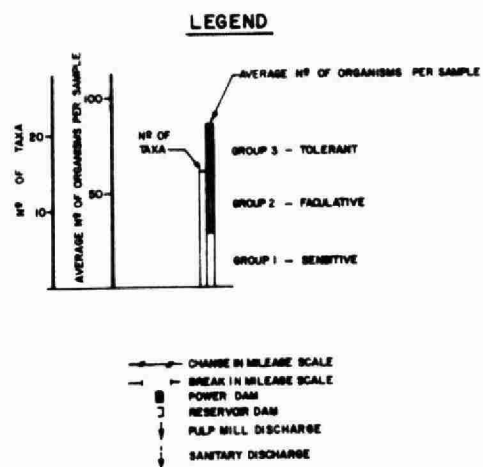
iv) Biological Characteristics

In addition to the 41 stations mentioned in the section above, biological samples were taken at five stations upstream and downstream of major municipal discharge points at Pembroke (RM 242.0) and Arnprior (RM 169.5).

Bottom fauna communities at most stations in the zone consisted of relatively low numbers of a wide variety of species with a good representation of clean water forms including the particularly sensitive mayfly, *Hexagenia* sp. The number of taxa per station and density of organisms per square foot increased downstream from an average of 8.3 and 12.4 respectively for stations in Allumette Lake to an average of 13.0 and 54.6 respectively for stations in Lake Deschenes (see Figure F-5). Group 1 species, sensitive to low concentrations of dissolved oxygen, were absent in the deeper portions of Allumette Lake (55 to 95 feet), Lake Rocher-Fendu (100 feet) and lower Lake Deschenes (80 to 100 feet) suggesting a degree of oxygen depletion (perhaps only periodically) in bottom waters.

Changes in the structure of benthic communities indicated a moderate degree of water quality impairment downstream from points of municipal waste discharges at Pembroke and Arnprior. At Pembroke, bottom organisms were eliminated entirely in the first 200 feet downstream from the municipal waste outfall and community diversity was restricted at stations along the shoreline for a distance of approximately two miles. Further downstream at Arnprior, the effect of discharges from the municipal sewage treatment plant to the river (via the Madawaska River) could be seen via a slight reduction in the variety of organisms (average of three taxa per station as compared with six taxa at upstream stations), a reduction in the number of sensitive forms, and a significant increase in the population of tubificid worms (*Pelosclex ferox*) to 145 per square foot. The above conditions were noted at four stations extending along the Ontario shoreline for a distance of approximately 1.7 miles downstream from Arnprior.

FIG. F-5 COMPOSITION AND ABUNDANCE
OF BOTTOM FAUNA COMMUNITIES AT
SELECTED STATIONS IN ZONE 3



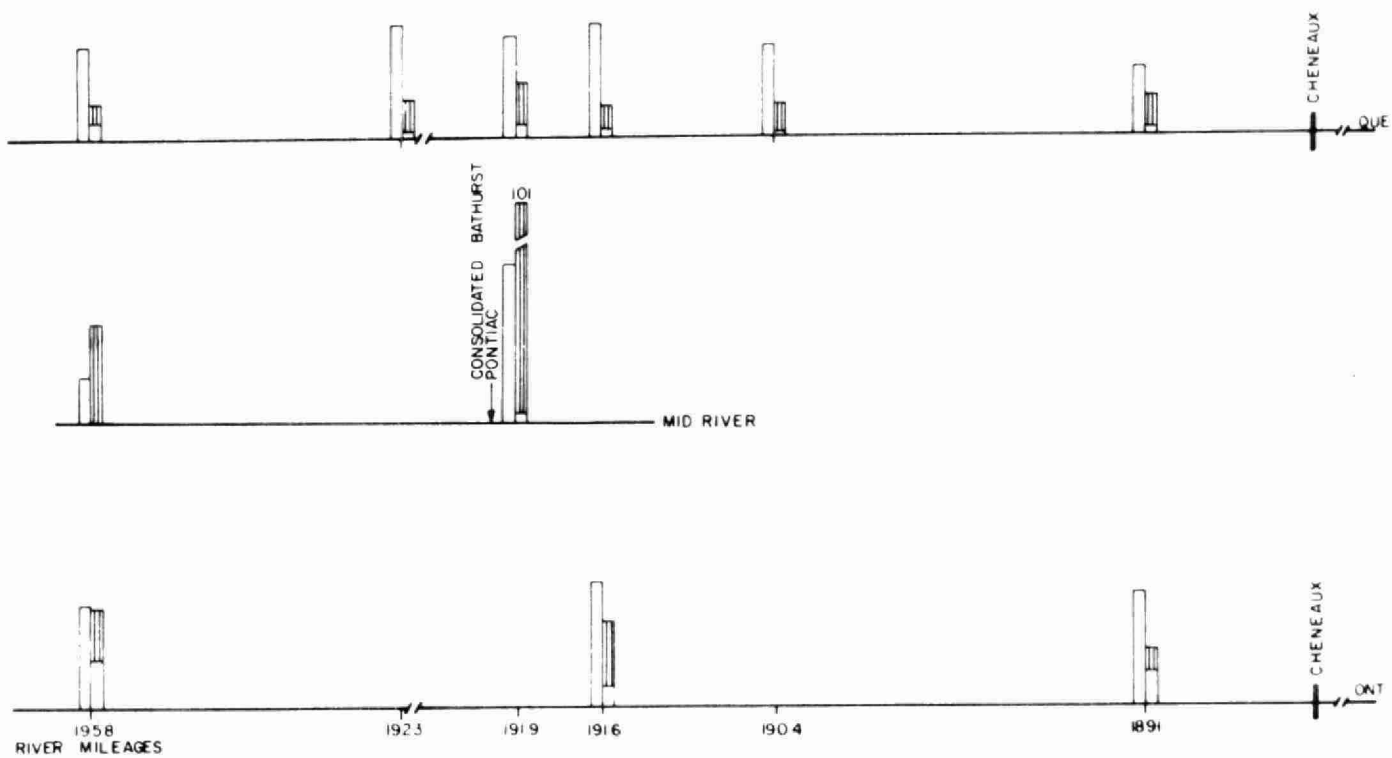
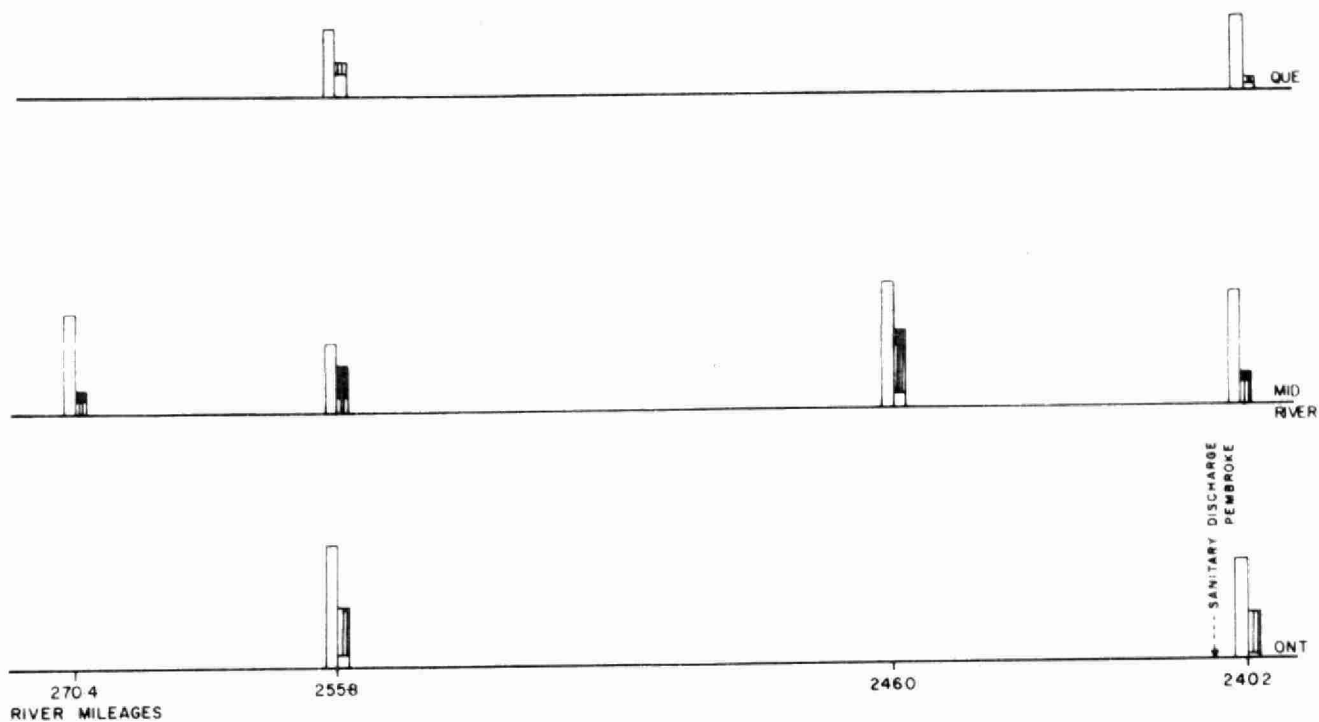
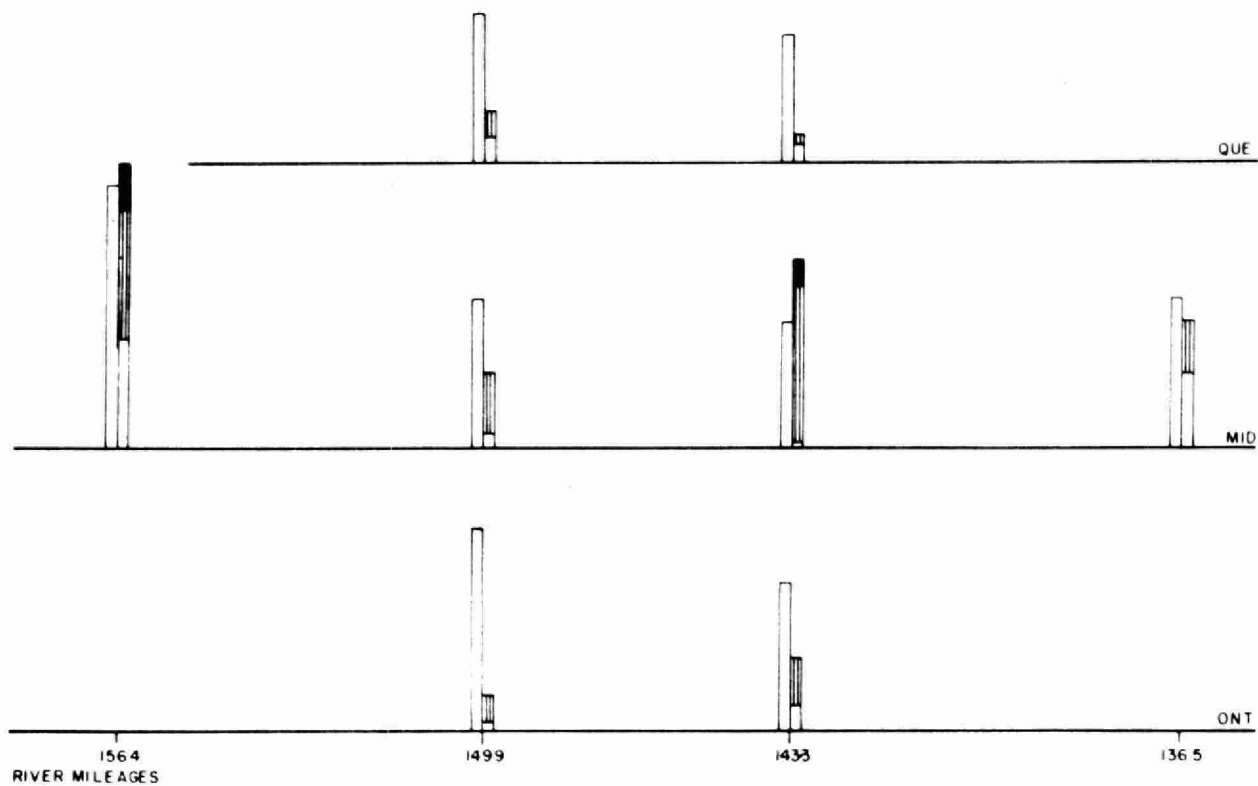
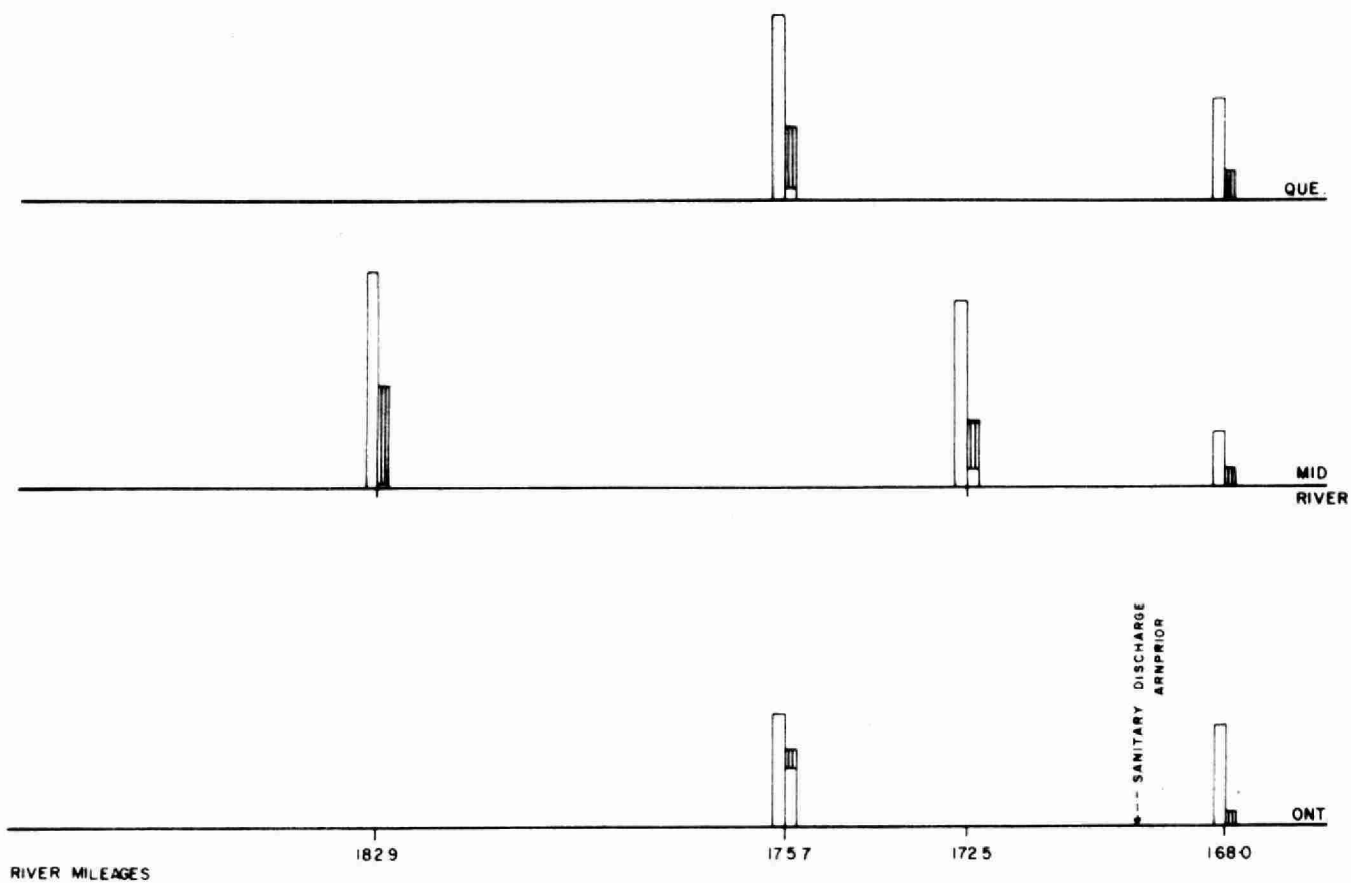


FIG F-5 SHEET 2 OF 3



On the basis of composition of bottom fauna communities, no evidence was detected of significant water quality impairment at stations downstream from the waste outfall from the Consolidated Bathurst (Pontiac) mill (see Figure F-5). Sensitive Group 1 organisms were present at all stations. An increase in the abundance of midge larvae (Chironomidae) at one station immediately below the outfall indicated only a local effect of organic enrichment.

Slime growths undoubtedly related to dissolved organic nutrients in the mill effluent were observed at the surface on fixed objects for a distance of approximately one-half mile below the outfall and slimes (*S. natans*) in conjunction with wood fibre have caused clogging problems in the cooling water distribution system at the Cheneaux hydro-electric generating station approximately four miles below the mill outfall. These growths were not detected in water samples (50 gallon concentrates) taken upstream from the dam and it is probable therefore that the clogging problem results from growths originating within the cooling water system (in response to low concentrations of nutrients and increased current velocities). However, it is possible that small, undetected quantities present in the downstream drift are sufficient to create clogging problems by virtue of the large volume of water used.

v) Oxygen Resources

Industrial wastes from the Consolidated Bathurst Company (Pontiac mill) at Portage du Fort (RM 188.9) exert a significant demand upon the dissolved oxygen resources of Zone 3. Present day paper mill loadings are sufficient to lower the dissolved oxygen level to about 6 mg/l in Lake Des Chats (RM 165 188) under critical temperature and streamflow conditions of 25°C and 12,500 cfs respectively. No other significant waste discharges or benthic sludge deposits have been noted in this zone. Dissolved oxygen levels remain consistently above 6 mg/l.

vi) Radiological Characteristics

Both the Nuclear Power Demonstration (NPD) reactor (RM 281.0) and the Atomic Energy of Canada nuclear laboratory (AEC) reactors at Chalk River (RM 263.1) contribute limited quantities of radioactive material to the Ottawa River. Water samples from eight stations in the vicinity of these inputs have been collected and analyzed on a monthly basis since 1966. No increase over background levels has been measured downstream from the NPD and only a slight increase has been detected below the AEC reactors. The level of gross alpha emitters is consistently

less than 1 pCi/l and the level of gross beta emitters are usually less than 10 pCi/l.

ZONE 2

Zone 2 extends from the Hydro-Quebec Carillon Generating Station (RM 56.8) to the Chaudiere Dam at the cities of Ottawa-Hull (RM 129.9) (see Figure G.4).

i) Physical Characteristics

From the Chaudiere Dam (RM 129.6) downstream for approximately 35 miles, river depths for the most part range from 50 to 60 feet. In the section extending from approximately 35 miles to 48 miles downstream of the Chaudiere Dam, mid-river depths are generally in excess of 100 feet. The remainder of the zone, downstream to the Carillon Dam (RM 56.9) has depths of approximately 60 feet with the exception of a short section (at RM 62.0) where the river is over 300 feet deep and in the forebay of the Carillon Dam where depths in excess of 100 feet occur.

The total solids levels in this zone were found to range from 45 to 110 mg/l but consistently averaged at about 70 mg/l at all the monitoring stations.

Suspended solids concentrations throughout the zone averaged approximately 8 mg/l whereas the turbidity varied considerably. Moving downstream, average turbidity concentrations decreased at first from 9 at Chaudiere Falls to about 5 Jackson units at Cumberland (RM 112.3) and then increased to about 7 Jackson units at Thurso (RM 102.3) and 11 Jackson units at the Perley Bridge (RM 68.0). Average turbidity levels then decreased to 10 Jackson units at the Carillon Dam.

Secchi disc readings in the upper section of the zone were reduced appreciably below waste outfalls from pulp and paper mills (E. B. Eddy, (Hull) and Canadian International Paper Company (Gatineau)). From the Chaudiere Dam downstream to RM 125.3, readings ranged between 3.8 and 6.3 feet (July) with the maximum and minimum readings occurring immediately downstream from the E. B. Eddy (Hull) discharge on the Quebec side and Ontario side of the river, respectively. A low Secchi disc reading of 2.0 feet occurred immediately downstream from the discharge of the Gatineau mill of the Canadian International Paper Company. Other readings along the Quebec side of the river downstream to the Lievre River (RM 112.3) averaged 3.4 feet as compared with an average of 5.0 feet along the Ontario shoreline in the same section. Below the Lievre River (RM 112.2 to RM 95.1) readings

were similar across the river averaging 4.6 feet (June). Below waste discharges from the Hawkesbury mill of the Canadian International Paper Company mill (RM 68.1), Secchi disc readings were reduced to an average of 3.4 feet (May) along the Ontario shore for a distance of 4.3 miles as compared with readings of 5.0 to 6.0 feet at upstream stations and stations downstream along the Quebec shore.

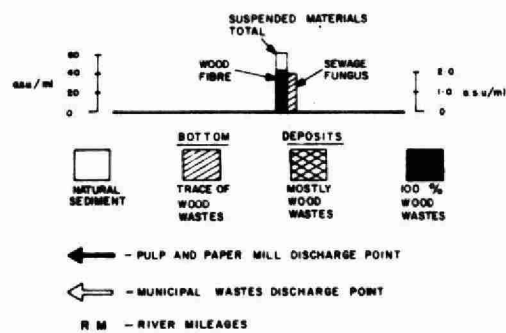
Bottom deposits of suspended solids materials from pulp and paper mill waste discharges were found in varying amounts at most stations throughout Zone 2 and in particular at stations located along the Quebec side of the river. The relative quantities of these materials (wood wastes varying from coarse chips to fibres) found in bottom deposits at selected stations throughout the zone is shown in Figure F-6. Wood waste materials made up a majority of the bottom deposits at stations downstream of waste discharges from all pulp and paper mills with the exception of the Thurso Pulp and Paper Company. Along the Quebec side of the river, sludge beds completely blanketed the bottom at stations immediately downstream from the E. B. Eddy Company (Hull) and the Canadian International Paper Company (Gatineau) with decreasing quantities being noted at stations progressively further downstream. At one station (RM 112.2) immediately below the Lievre River (which receives wastes from the pulp and paper mill of the James MacLaren Company), sludge deposits comprised most of the bottom materials. From this point downstream to RM 70.2, trace amounts were found at all stations in shallow depths along the Quebec shore. However, substantial quantities of waste solids were deposited in depths of 90 to 125 feet at RM 93.2 and RM 84.8. Waste materials were absent in sediments at RM 70.2 but re-occurred at RM 66.1 (Quebec side) as a result of waste discharges from the Hawkesbury mill of the Canadian International Paper Company. Along the Ontario shore, appreciable sludge deposits occurred locally downstream from the Hawkesbury mill outfall with trace amounts being found at all other downstream stations.

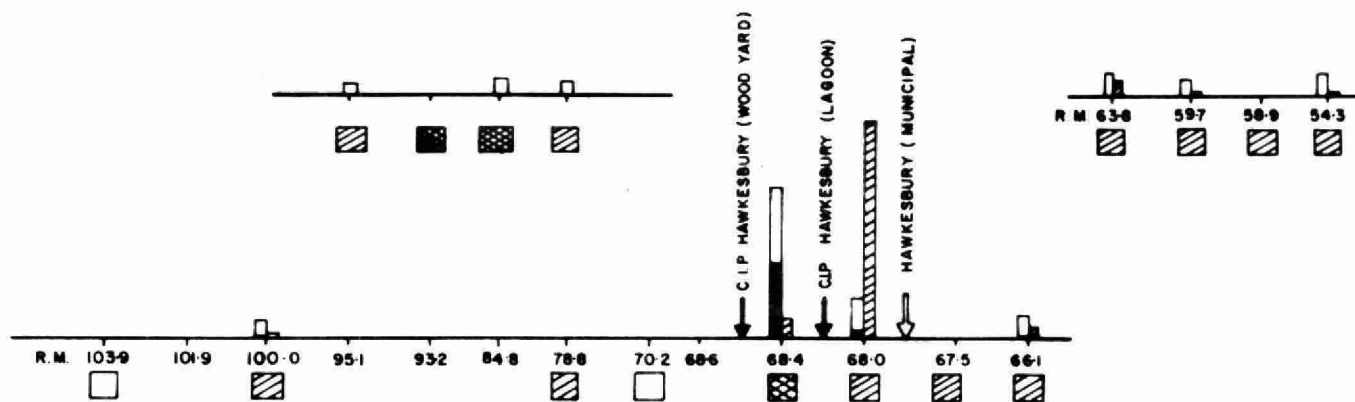
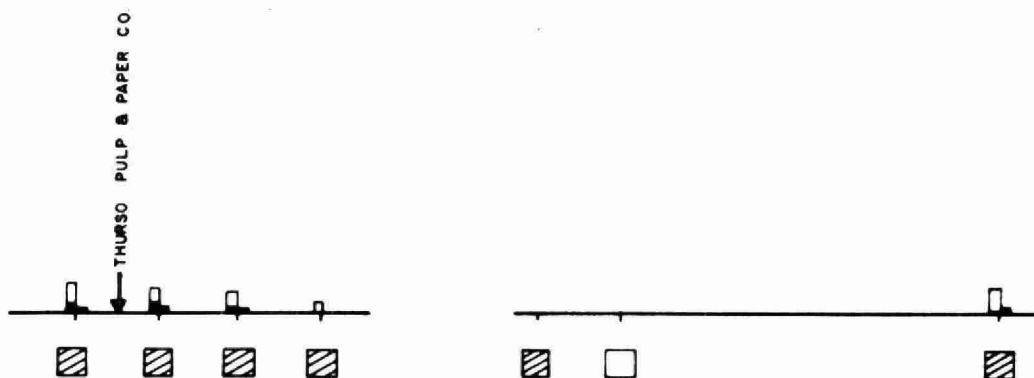
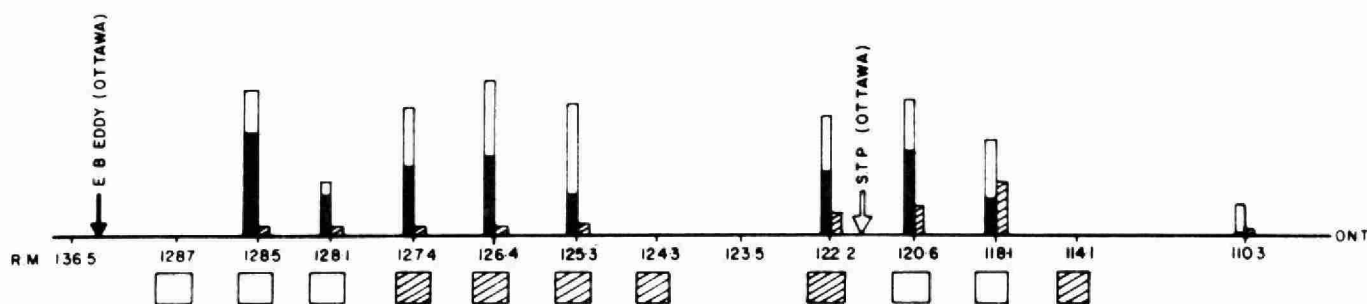
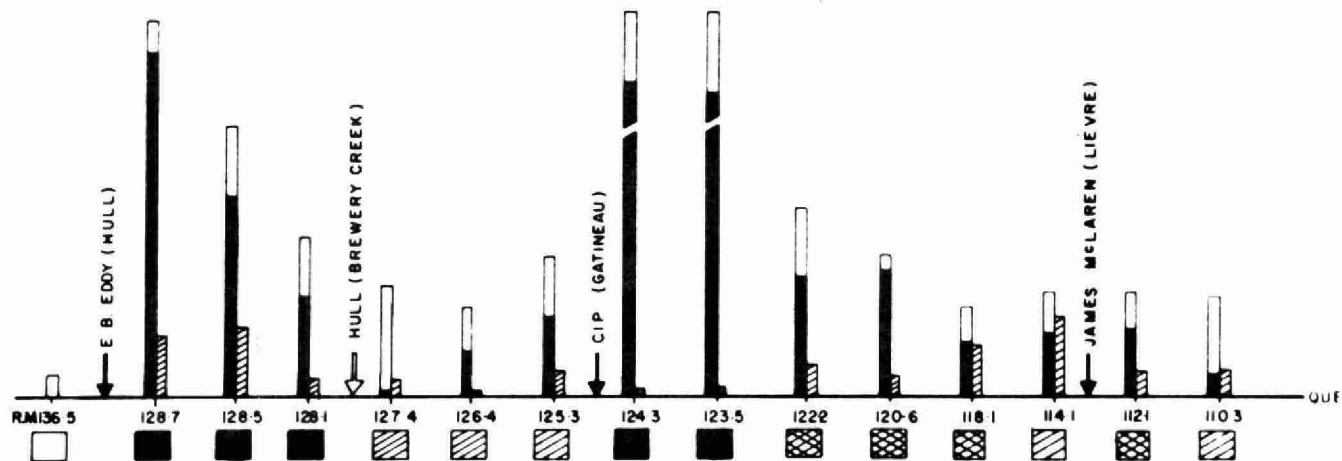
Floating sludge mats resulting from the resuspension of deposited sludge materials and consisting of compacted wood chips and fibres mixed with slime growths were prevalent on the river, particularly during summer periods, from approximately RM 122.2 to RM 111.3 and from RM 93.2 to RM 84.8. This distribution coincided closely with that of greatest deposition of sludge materials on bottom.

Concentrations of suspended wood fibres in Zone 2 of the river are shown in Figure F-6. Downstream from waste discharges from the Hull mill of the E. B. Eddy Company and the Gatineau mill of the Canadian International Paper Company, concentrations reached very high levels (compared with levels at upstream

FIG. F - 6 CONCENTRATIONS (a.s.u./ml) OF TOTAL
SUSPENDED MATERIAL, WOOD FIBRE AND SEWAGE
FUNGUS AND COMPOSITION OF BOTTOM DEPOSITS
AT SELECTED STATIONS IN ZONE 2

LEGEND





stations, see Figure F-4), of 250 and 464 asu/ml, respectively, and decreased to 28.3 and 38.9 asu/ml at distances of 2.1 and 6.2 miles downstream from these respective outfalls. At stations along the Ontario shore, concentrations averaged 45.0 asu/ml downstream to the Lievre River (RM 112.3). The Masson mill of the James MacLaren Company had little effect on the fibre concentrations in the river. From the Lievre River downstream to RM 100.0, concentrations were relatively low averaging 4.2 asu/ml and further downstream to Hawkesbury, concentrations were less than 1.0 asu/ml. Immediately downstream of waste discharges from the Canadian International Paper Company mill at Hawkesbury concentrations increased at one station to 55.1 asu/ml followed by a decrease to 2.6 asu/ml at approximately 2.2 miles downstream and to less than 1.0 asu/ml at stations further downstream.

Threshold odour analyses on water samples taken upstream and downstream of pulp and paper mill discharges to the river are given in Table F-7. In general, a reasonable Threshold Odour Number (TON) for water of potable quality can be four or less and for most other uses should be eight or less. High TON values were recorded downstream of all mill discharges but decreased rapidly and approached acceptable levels at distances ranging from 450' to two miles downstream of the respective outfalls.

On two different days colour data were collected at eleven different locations in the zone. From these data there did not appear to be any consistent trend downstream. A marked difference between readings taken from the Ontario and Quebec sides of the river was noted, indicating that the variation could be attributed to specific inputs. The levels ranged from 21 to 58 Platinum-Cobalt units, with the majority in the lower end of the zone at about 35 Platinum-Cobalt units.

Quantities of oil were frequently observed on the surface of the river between the Ottawa-Hull area and the mouth of the Lievre River (RM 113.3). On occasion, these oil slicks covered the entire surface from shore to shore at various locations along the river.

There is usually less than 1°C difference in water temperature between the two ends of the zone. In the winter, the average water temperature for the whole river approaches 0°C with the surface freezing over. Although the maximum varies from year to year, the summer water temperature reaches a high of about 25°C.

The annual fluctuation in water levels varies from one end of the zone to the other. At the Carillon Dam (RM 56.8), the difference in water levels is about 2 feet over the year, whereas at the upper end, the fluctuation is about 4 feet. However, the

TABLE F-7

Comparison of Threshold Odour Numbers at Stations
Upstream and Downstream of Waste Discharges from
Pulp and Paper Mills in Zone 2 of the Ottawa River

Industry	Sampling Site	Threshold Odour Number (1) (Arithmetic Mean)
E. B. Eddy Ottawa	upstream	2.8
	200' downstream	60.0
	450' downstream	6.5
E. B. Eddy Hull	600' downstream	56.0
Canadian International Paper Gatineau	upstream	6.0
	200' downstream	110.0
	2,800' downstream	18.0
	8,300' downstream	12.3
Thurso Pulp and Paper	upstream	3.6
	200' downstream	200.0
	2,300' downstream	12.3
	6,300' downstream	25.0
Canadian International Paper Hawkesbury	upstream	8.0
	200' downstream	133.0
	2,800' downstream	12.4
	4,200' downstream	13.0

(1) Number of dilutions required to obtain a concentration at which odour is barely perceptible.

Carillon Dam is regulated to give steady levels during the summer months.

ii) Chemical Characteristics

The monitoring data indicated a downward trend in dissolved oxygen levels moving downstream through the zone. Many low values between 5.0 and 5.5 mg/l were recorded at Cumberland Ferry (RM 112.3) and Thurso Ferry (RM 102.3).

There appeared to be no downstream trend in the average BOD concentration (2-3 mg/l). However, most of the high values were recorded downstream of Hiawatha Park (RM 118.8) to the Carillon Dam (RM 56.8). One specific point worthy of mention was the consistently high values of BOD on the Quebec side of the river at Hiawatha Park.

Nitrogen and phosphorus concentrations varied widely depending on the location within the zone. Average concentrations of total phosphorus (as P) increased from 0.02 mg/l at the Alexandria Bridge (RM 128.9) to about 0.06 mg/l at Cumberland and then decreased to 0.04 mg/l at Carillon Dam. The maximum concentrations recorded follow this same trend. Soluble phosphorus levels (as P) were generally 0.01 mg/l with a slightly higher average at 0.02-0.03 mg/l at the Cumberland Ferry. Although there was no general trend in ammonia and total kjeldahl concentrations, the average ranging between 0.05 and 0.11 mg/l (as N) for ammonia and between 0.41 and 1.03 mg/l (as N) for total kjeldahl, some very high values were recorded at various times. An ammonia concentration of 2.3 mg/l and a total kjeldahl concentration of 3.7 mg/l was recorded on the Quebec side at the Alexandria Bridge (RM 128.9) and a maximum of 1.0 mg/l for free ammonia and 3.9 mg/l for total kjeldahl at the Perley Bridge (RM 68.0). Nitrite levels found in this zone were usually less than or equal to 0.01 mg/l (as N). Average nitrate concentrations were fairly consistent at 0.08 mg/l (as N) from the upstream end of the zone to Hiawatha Park. Average (0.09 mg/l) was less at Cumberland, but was higher again from the Thurso Ferry to the Carillon Dam where the average for the past two years was 0.16 mg/l as N.

Conductivity levels at the McDonald-Cartier Bridge (RM 128.9) averaged 85 micromhos, then dropped to an average of 75 micromhos at Cumberland, increased to 80 micromhos at the Thurso Ferry, 85 micromhos at the Perley Bridge, and then fell again to 72 micromhos at the Carillon Dam. Maximum and minimum values recorded were usually within 15% of the average.

Total hardness and alkalinity can generally be represented by average values for the whole zone. The total

hardness averaged 30 mg/l (as CaCO₃) except at the upper end of the zone where the average was about 35 mg/l (as CaCO₃). For the bulk of the river in Zone 2, the reported alkalinities averaged 20 mg/l (as CaCO₃); however, the average was slightly higher (23 mg/l as CaCO₃) at the beginning of the zone and higher in the last ten miles of the zone (25-27 mg/l as CaCO₃). The pH was found to vary over the past three years from 6.4 to 8.4.

Three other chemical parameters have been measured on a fairly regular basis: chemical oxygen demand (COD), iron and sulphates. COD levels were found to vary considerably from year to year making it difficult to determine downstream trends. Averages for COD of 34 mg/l at the upper end of the zone from the Chaudiere Dam to Hiawatha Park and 30 mg/l from Hiawatha Park to Thurso and 36-40 mg/l for the lower end from Thurso to Carillon indicated a trend similar to that of other parameters. The average concentration of iron (as Fe) was about 0.40 mg/l as far downstream as Cumberland increasing to about 0.70 mg/l at the Perley Bridge and then steadily decreasing to about 0.40 mg/l at the Carillon Dam. No trend was observed in the sulphate concentrations, which averaged between 0.12 mg/l and 0.15 mg/l with a maximum of 0.20 mg/l and a minimum of 0.08 mg/l.

Periodically water samples from both ends of the zone have been analyzed for various compounds such as copper, chromium, lead, zinc, nickel and arsenic. The only result that showed a significantly high concentration was 0.28 mg/l of lead (as Pb) in a single sample at the Carillon Dam. These results are listed with the monitoring results in Volume II.

Two pulp and paper mills on the Ottawa River, both located in Zone 2, have used mercurial slimicides. Discharges of these slimicides to the river have resulted in these materials entering the aquatic food chain which in turn has caused the mercury contamination of muscle tissue of various sport and commercial fish species. Table F-8 presents analytical results on fish samples collected in 1969 from Zone 2 along with results from Zones 3, 4 and 5 for comparative purposes. The marked increase in concentrations in fish from Zone 2 is readily apparent and represents an increase of from two to six times that of background levels in the upper river. Average concentrations for species analysed, with the exception of sturgeon, bullhead and carp, were in excess of the 0.5 mg/kg upper level considered safe for human consumption and maximum values for all species reached or exceeded this level with a maximum concentration recorded of 5.0 mg/kg in one specimen of walleye. No trend in concentrations was discernable between upstream and downstream sections of the zone. The average concentration for whitefish and the maximum concentrations for northern pike and walleye in the upper river exceeded 0.5 mg/kg; these levels cannot be

TABLE F-8

Concentrations of Mercury in muscle tissue of various species of fish in Zones 2, 3, 4 and 5 of the Ottawa River, 1969

Species	Mercury as Hg (mg/kg)			Number of Samples
	Mean	Max.	Min.	
Zone 5				
Northern Pike	0.45	1.10	0.18	6
Yellow Perch	0.22	-	-	1
Whitefish	0.54	1.13	0.12	7
Cisco	0.21	0.28	0.17	4
Suckers	0.26	0.43	0.10	5
Zone 4 and 3				
Sturgeon	0.27	0.40	0.15	5
Walleye	0.26	0.60	0.08	4
Northern pike	0.23	0.82	0.15	5
Yellow Perch	0.16	0.23	0.10	5
Suckers	0.11	0.43	0.06	13
Zone 2				
Sturgeon	0.49	1.38	0.05	7
Walleye	1.58	5.00	0.35	23
Northern pike	0.97	1.38	0.18	9
Yellow Perch	0.67	1.42	0.21	7
Sauger	0.94	1.30	0.55	3
Brown Bullhead	0.29	0.50	0.12	6
Rock Bass	1.21	1.68	0.80	3
Carp	0.43	0.60	0.18	3
Suckers	0.65	1.53	0.23	17

related to any point source of contamination and possibly represent contamination from natural background levels of mercury in the Ottawa River.

Concentrations of mercury in river sediments (Table F-9) further illustrate the level of contamination in Zone 2. Average concentrations for the zone represent an approximate fourfold increase over those for upstream zones. While maximum concentrations of 1.1 mg/kg and 2.0 mg/kg occurred immediately downstream from the waste outfalls of the E. B. Eddy Company (Hull) and the Canadian International Paper Company (Gatineau), respectively, there was no appreciable downstream trend in average concentrations. Levels were lowest in the section of the river downstream from the Lievre River to the Petite Nations and the South Nation rivers. Levels were consistently high throughout the twelve miles further downstream where, as referred to previously, deposition of waste solid materials was also high.

iii) Bacteriological Characteristics

On several occasions during the year, the bacteriological quality of the water entering the zone was unfit for water-contact recreation. One mile downstream, at the Alexander Bridge (RM 128.9), untreated municipal and industrial waste discharges had contributed additional bacterial contamination. The Hull slaughterhouse of the Canada Packers Company discharges untreated wastes to Brewery Creek resulting in gross bacterial contamination of the watercourse. In turn, Brewery Creek and to a lesser degree the Rideau River in Ottawa contribute to the overall degraded bacteriological condition of the Ottawa River. The following tables indicate the numbers of enteric bacteria in the Ottawa and Hull areas.

Brewery Creek

	Total Coliform /100 ml	Fecal Coliform /100 ml	Enterococcus /100 ml
1968	40,000 (7)	13,000 (4)	3,130 (4)

Rideau Canal

1968	2,121 (4)	158 (2)	202 (2)
1969	259 (6)	39 (2)	

Numbers indicated are geometric means () number of samples

The adverse effect of these inputs on the river was evidenced by samples taken from both sides of the river.

TABLE F-9

Concentrations of Mercury in sediments at various locations
in the Ottawa River, 1968 to 1969

Location	Mercury as Hg (mg/kg)			Number of Stations
	Mean	Max.	Min.	
Zone 5				
RM 385.5	0.14	-	-	1
Zone 4				
RM 372.2 to 366.2	0.10	0.28	0.02	4
RM 362.2 to 340.9	0.09	0.12	0.06	4
RM 339.5 to 288.7	0.07	0.10	0.02	3
Zone 3				
RM	0.19	-	-	1
RM 195.8 to 188.5	0.07	0.10	0.05	7
RM 182.9	0.07	-	-	1
RM	0.15	0.20	0.09	3
Zone 2				
RM 129.1 to 125.3	0.39	1.1	0.03	13
RM 124.3 to 118.1	0.42	2.0	0.03	12
RM 112.2 to 95.1	0.23	0.40	0.08	8
RM 84.8 to 78.8	0.56	0.83	0.26	4
RM 70.0 to 58.9	0.42	0.85	0.06	7

RM 128.3
(at mouth of Brewery Creek)

	Total Coliform /100 ml	Fecal Coliform /100 ml	Entero- coccus /100 ml	Plate Count /100 ml
1969 Ontario side	260 (5)	152 (7)	42 (7)	5.9×10^4 (4)
1969 Quebec side	13,253 (5)	2,146 (5)	336 (5)	2.4×10^6 (3)
Numbers indicated are geometric means				() number of samples

Data for both sides indicate unacceptable conditions for body contact recreation.

The two tributaries, Lake Creek (RM 127.8) and the Gatineau River (RM 127.4), were also found to have bacterial counts that indicate unacceptable conditions for body contact recreational use. From this point, the river remained in approximately the same condition until Hiawatha Park (RM 119.5) where a significant increase in contamination was noted, especially during 1968.

Hiawatha Park

	Total Coliform /100 ml	Fecal Coliform /100 ml	Entero- coccus /100 ml
Quebec 1968	18,992 (5)	3,256 (2)	141 (2)
69	30,133 (3)	49 (2)	-
Ontario 68	10,274 (5)	-	-
69	1,040 (4)	16 (3)	31 (2)
Numbers indicated are geometric means			() number of samples

The bacterial quality of the river continued to deteriorate as it flowed past Cumberland.

Cumberland

	Total Coliform /100 ml	Fecal Coliform /100 ml	Enterococcus /100 ml
1968	13,047 (15)	2,113 (6)	764 (6)
1969	25,752 (6)	2,860 (6)	143 (4)
Numbers indicated are geometric means			() number of samples

The Lievre River (RM 113) contributed to the bacterial counts at this point.

Moving downstream from Thurso (RM 102.3), the river began to show definite signs of improvement. Bacterial contamination increased again at Hawkesbury (RM 68.0) but from this point on, many of the samples indicated only marginal contamination. At the Carillon Dam (RM 56.8), the following levels were found over a period of two years:

Carillon Dam

	Total Coliform /100 ml	Fecal Coliform /100 ml	Enterococcus /100 ml
1968	851 (25)	110 (13)	7 (13)
1969	306 (10)	29 (10)	8 (10)
Numbers indicated are geometric means			() number of samples

Four tributaries join the Ottawa River in the lower fifty miles of this zone. The South Nation River (RM 94.2) and the Kinange River (RM 84.5) in 1968 and 1969, and the Rouge River in 1968 showed excessive bacterial contamination. However, the Blanche River and the Rouge River were found to be acceptable for recreational use in 1969.

A special study was undertaken to determine the extent and concentrations of sulphur bacteria in the water and sediment of this zone.

The number of sulphate reducers (Desulfovibrio) in the surface water was found to increase from less than 2-10/100 ml to 800/100 ml just below E. B. Eddy (Hull). After reaching a peak of 3.0×10^3 /100 ml at the effluent of the Canadian International Paper Company (Gatineau), this level declined to 160/100 ml and remained constant until Rockland (RM 105.7). Below the Thurso Pulp and Paper discharge, the number of sulphate reducers increased slightly to 800/100 ml before falling off again. Upstream of Hawkesbury (RM 68.1), the mean population in the

surface waters was less than 2/100 ml on the Ontario side and 20/100 ml on the Quebec side. However, the count reached a peak again at the Canadian International Paper Company (Hawkesbury) effluent and remained between 10-70/100 ml past RM 63.0.

The sulphur oxidizers (*Thiobacillus thiooxidans* and *Thiobacillus thioparus*) on the Quebec side followed the pattern of the sulphate reducers with peak numbers occurring at Canadian International Paper Company (Gatineau) and the Thurso Pulp and Paper Company. On the Ontario side, the levels were generally lower until Hawkesbury. The number of *Thiobacillus* increased from less than 10/100 ml to 200/100 ml at the Canadian International Paper Company (Hawkesbury) discharge and remained high at the last sampling point (RM 60.6).

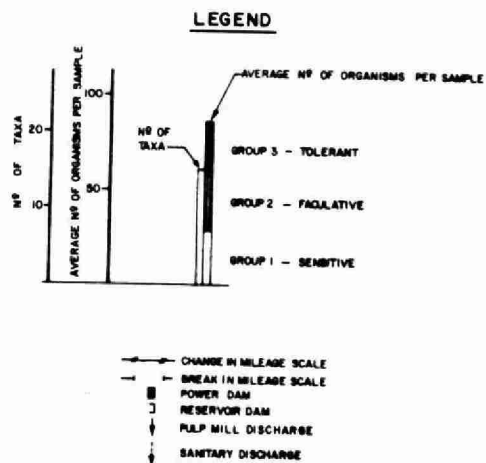
In the sediment, the peak populations of the sulphur reducers on the Quebec side were found below E. B. Eddy (Hull), below the Canadian International Paper Company (Gatineau), below the mouth of the Lievre River, and below the Thurso Pulp and Paper mill where the level reached 10^4 /gm. On the Ontario shore, counts were much lower except at RM 121.4 where a level of 3.6×10^3 /gm was recorded. Further downstream at Hawkesbury, the count increased from about 100/gm above the mill to 10^4 gm below the discharge of the Canadian International Paper Company (Hawkesbury). These levels gradually decreased to 10^3 /gm at RM 60.6.

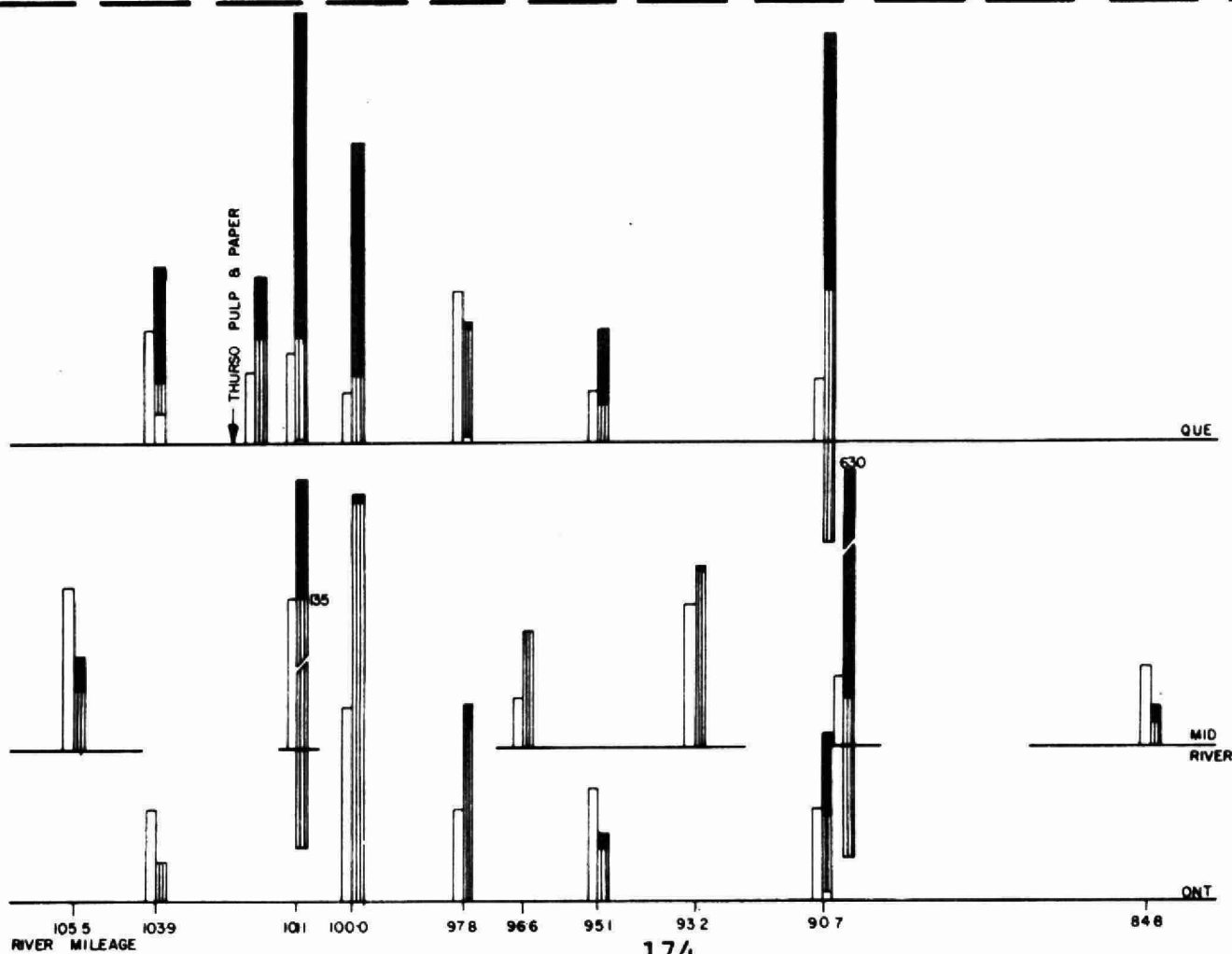
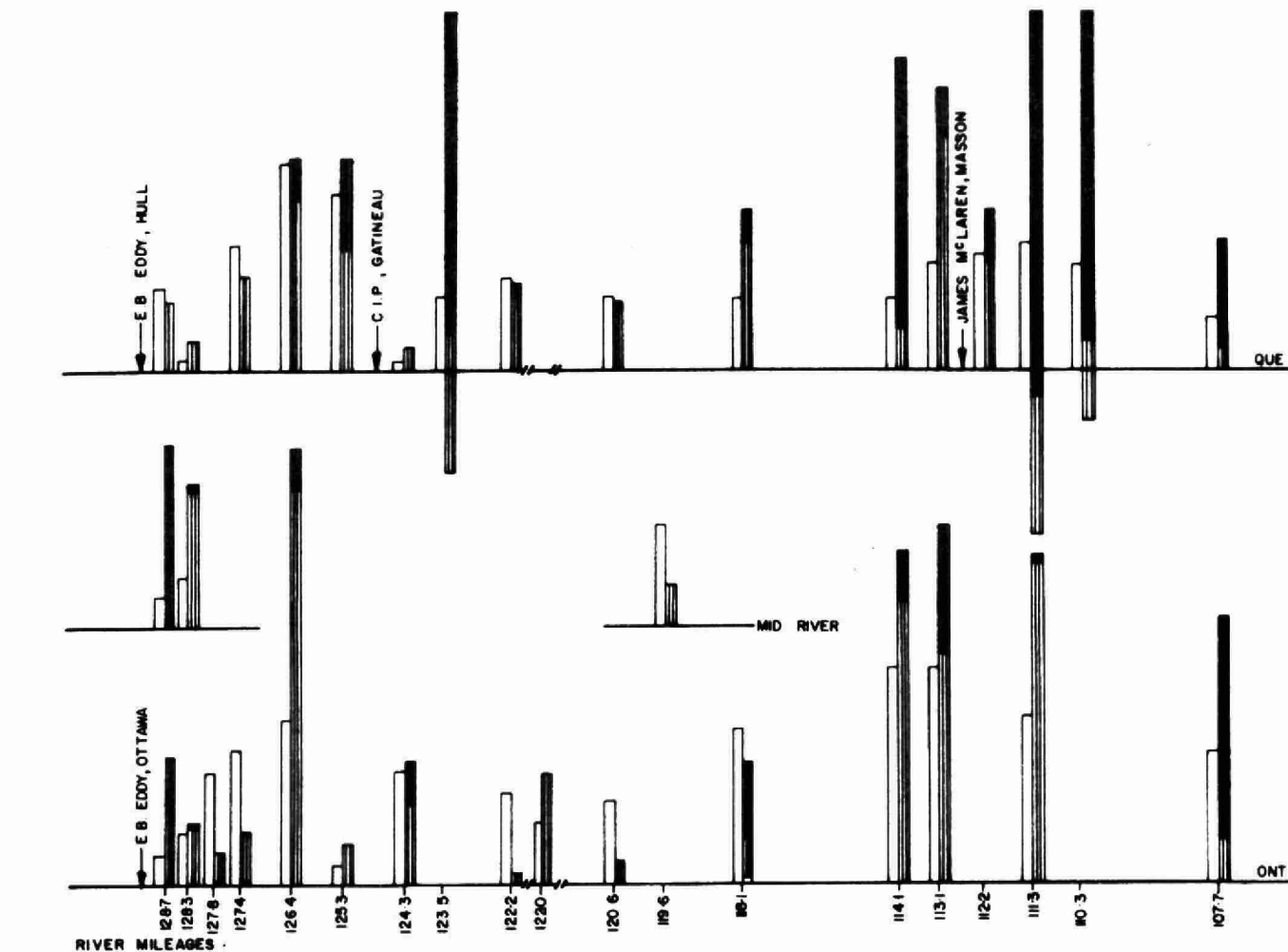
The concentration of sulphur oxidizers in the sediment followed the same trends as the sulphate reducers with maximum numbers of 10^2 - 10^4 /gm appearing below the pulp and paper mills in the upper part of the zone. Similarly, a jump occurred at the Canadian International Paper Company (Hawkesbury) with counts increasing from less than 100/gm to 10^2 - 10^4 /gm on the Ontario side; the maximum count of *Thiobacillus*/gm was recorded one-half mile below the Perley Bridge (RM 68.0). The level was only slightly lower at the last sampling point (RM 60.6).

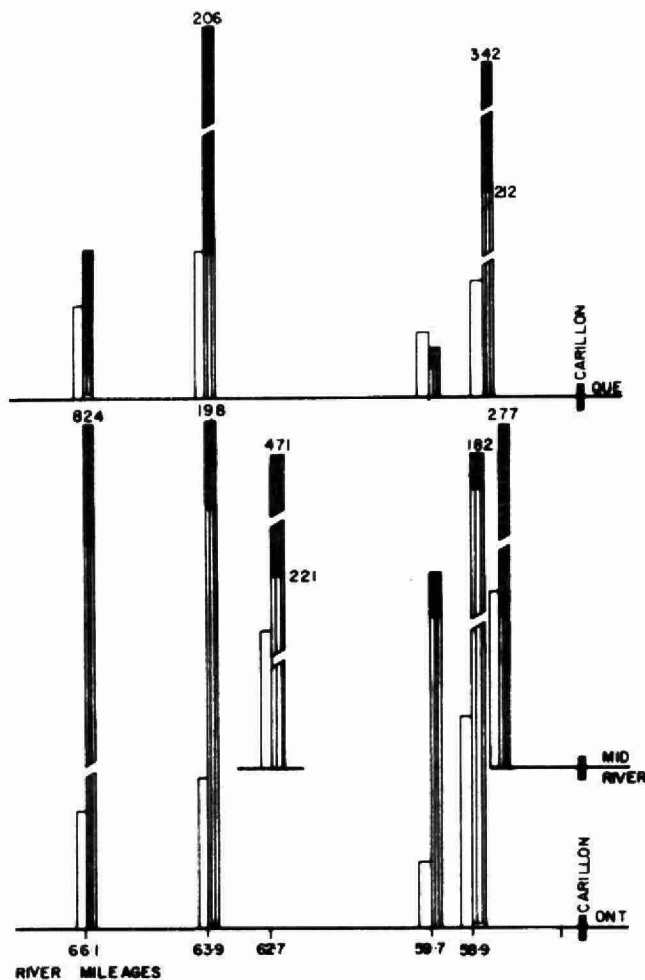
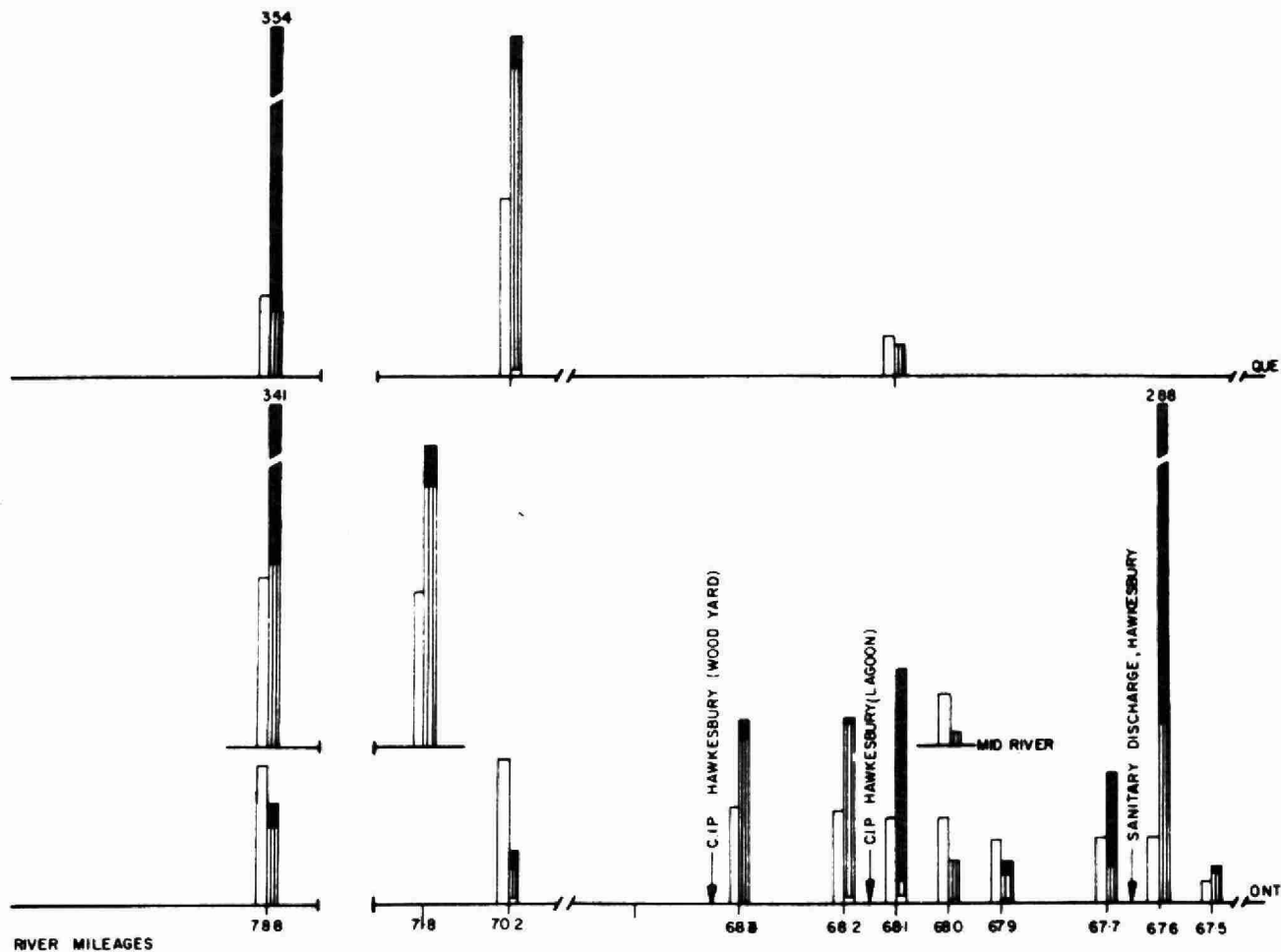
iv) Biological Characteristics

The abundance and composition of bottom fauna communities for Zone 2 are shown in Figure F-10. Throughout the zone, natural physical factors such as current velocities, depths and composition of sediments were variable from station to station and accounted, to some extent, for the observed variability in bottom fauna communities. However, changes in the structure of bottom fauna communities, to a considerable extent, indicated corresponding changes in physical and chemical impairment of the river.

FIG. F-10 COMPOSITION AND ABUNDANCE
OF BOTTOM FAUNA COMMUNITIES AT
SELECTED STATIONS IN ZONE 2







In general, bottom fauna communities of Zone 2 as a whole were substantially altered relative to those of Zone 3. This was manifested primarily in a general increase in abundance of organisms, a shift in species composition towards more tolerant and semi-tolerant forms and a total elimination or restriction of sensitive species at most stations.

A comparison of bottom fauna communities throughout the zone provides an indication of the degree and extent of impairment of water quality below various waste discharges and the relative effect of each source.

Because of rock substrate in the section of river from the Chaudiere Dam downstream to the Alexandria Bridge, it was not possible to sample naturally-occurring bottom fauna communities. However, rock substrate samplers placed in this section of river were colonized by a wide variety of organisms including many sensitive species and on the basis of these samples, there was no indication of any significant alteration in communities downstream from the waste discharge of the E. B. Eddy Company (Ottawa).

In the section of river from RM 129.0 to RM 105.5, which receives waste discharges from the E. B. Eddy Company (Hull), the Canadian International Paper Company (Gatineau) and the James MacLaren Company (Masson) pulp and paper mills and the municipal waste discharges from the municipalities of Ottawa, Hull, Gatineau and Pointe Gatineau, species sensitive to organic pollution were absent at most stations. The number of taxa per station decreased below major waste inputs followed by a gradual increase at varying distances further downstream which coincided with extremely high numbers of tolerant (Tubificidae) and semi-tolerant (Chironomidae and Sphaeriidae) organisms in response to organic enrichment. Bottom fauna communities at stations on the Quebec side of this section of the river, as compared with those on the Ontario side, indicated a greater degree of impairment of water quality. Community structure was comprised of a greater percentage of tolerant Group 3 organisms which in most cases included only the very tolerant sludgeworm *Limnodrilus hoffmeisteri*. Furthermore, relatively intolerant unionid clams were absent at all stations on the Quebec side of the river, but were found consistently at stations along the Ontario side. At RM 103.9, some 27 miles downstream from the Chaudiere Dam, partial recovery was indicated by a decrease in overall abundance of fauna and the reappearance of significant numbers of sensitive Group 1 organisms. Further downstream (RM 101.9 to RM 78.8), bottom fauna abundance increased and tolerant Group 3 species dominated communities immediately below waste discharges from the Thurso Pulp and Paper Company and at RM 90.7 and RM 78.8 (particularly at deeper stations) where substantial deposits of

sludge occurred. While some recovery occurred downstream from RM 78.8, as indicated by increasing diversity and decreasing numbers of tolerant species, this trend was reversed below waste discharges from the Hawkesbury mill of the Canadian International Paper Company and discharges of untreated municipal wastes from the Town of Hawkesbury. These wastes promoted a decrease in diversity, an increase in total numbers of organisms and a predominance of tolerant species (particularly at deeper stations) throughout the eleven miles of river downstream to the Carillon Dam.

Composition of bottom fauna communities throughout the zone was governed largely by the degree of sludge (wood wastes) accumulations in bottom deposits. Sensitive species occurred only at stations where natural sediments were predominant and, conversely, communities were most restricted in terms of diversity and total numbers of organisms where sludge deposition was greatest. On the other hand, fauna samples from artificial substrates suspended over sludge deposits revealed a consistently greater variety of taxa and in all cases included sensitive species. In these samples, total diversity and variety of sensitive forms were generally lower at stations below pulp mill discharges along the Quebec side of the river as compared with stations located along the Ontario side and upstream of RM 128.7. These observations indicated a definite, although relatively minor, adverse affect on bottom fauna communities attributable to impairment of physical and chemical aspects of water quality in the water column. They further substantiate the conclusion that major alterations of bottom fauna communities, particularly in species composition, were largely the result of deposition and accumulation of waste solid materials from pulp mill discharges.

Growths of sewage slimes were abundant on fixed substrates in the river along the Quebec shore at distances of approximately 0.2 to 1.1 miles and 1.8 to 6.7 miles downstream from the waste outfalls at the E. B. Eddy Company (Hull) and Canadian International Paper Company (Gatineau), respectively, and also for a distance of approximately one mile along the Ontario shore below the Canadian International Paper Company (Hawkesbury) outfall. At various stations downstream of these outfalls, concentrations of sewage slimes in surface water samples (from detachment and downstream drift) were high (see Figure F-10) and at most stations, particularly along the Quebec shore downstream to the Lievre River, substantial accumulations were observed in bottom deposits. Areas of slime growth below waste discharges from the James MacLaren Company and Thurso Pulp and Paper Company mills were not extensive and concentrations in water samples were not increased.

v) Oxygen Resources

The dissolved oxygen resources of Zone 2 are depleted by benthic sludge deposits extending from the confluence of South Nation River (RM 95.0) with the Ottawa River to L'Crignal Bay (RM 76.0), and by wastewater discharges from eight major industries and more than a dozen municipalities. An intensive waste assimilation survey of Zone 2 undertaken during July 1968 revealed that the combined paper mill discharges from the E.B. Eddy Company at Ottawa and Hull (RM 129.9), the Canadian International Paper Company at Gatineau (RM 124.7), the James MacLaren Company at Masson (RM 112.5), the Thurso Pulp and Paper Company at Thurso (RM 102.2) and significant volumes of domestic wastes from the Ottawa-Hull area lowered dissolved oxygen concentrations from 8.1 mg/l at Chaudiere Dam to 5.3 mg/l at Hawkesbury (RM 68). With further addition of paper mill wastes from the Canadian International Paper Company Ltd. at Hawkesbury, the dissolved oxygen level reached a minimum of 4.3 mg/l at the Quebec Hydro Carillon generating station (RM 56.8).

During the July 1968 survey, the average water temperature was 24°C and the average streamflow was 48,800 cfs at the Quebec Hydro Carillon generating station. For present day waste loadings and critical stream conditions of 30,000 cfs streamflow at Carillon and a 25°C water temperature, a minimum dissolved oxygen level of 2.0 mg/l at Carillon could be expected.

ZONE 1

Zone 1 lies within the Province of Quebec and extends from the confluence of the Des Prairies River with the St. Lawrence River (RM 0.0) to the Hydro-Quebec Carillon Generating Station (RM 56.8). Only two monitoring stations were established in this zone, at the Carillon Dam and at the Oka Ferry (RM 39.0). Much of the physical and chemical data summarized below were taken from the results for these two stations, and therefore cannot be considered entirely representative for the whole zone. Biological characteristics were examined at thirteen stations on five ranges from RM 54.3 to RM 39.0 (Oka).

i) Physical Characteristics

Total solids levels averaged about 70 mg/l with the greatest fluctuation occurring at the Carillon Dam (RM 56.8). Suspended solids concentrations decreased from an average of 10 mg/l at the upper end of the zone to an average of 5 mg/l at Oka (RM 39.0). Turbidity showed a similar trend ranging from 10 to 5 Jackson units at the same two stations. Suspended wood fibres were not present in one sample taken at approximately one-half mile downstream of the Carillon Dam and are probably not a significant fraction of the suspended solids in this zone.

Small quantities of wood chips were found at most stations downstream to Oka. However, these did not appear to be of recent origin and it is likely that they were deposited prior to construction of the Carillon Dam.

Colour data collected near the upper end of the zone ranged from 30 to 45 Platinum-Cobalt units. Since these data were collected on only two different days, they can only be used as an indication of existing levels.

The water temperature varied from a low of 0°C in the winter to a high of 24°C in the summer.

ii) Chemical Characteristics

Over the year, average dissolved oxygen levels were about the same for both monitoring stations in the zone. Levels as low as 4.0 and 5.0 mg/l were recorded at the Carillon Dam (RM 56.8) and a low of 4.6 mg/l at Oka Ferry (RM 39.0). The BOD concentration at the dam ranged from 0.6 to 3.0 mg/l, with an average of 1.5 mg/l, whereas at Oka, the range was from 0.5 to 2.4 mg/l with a slightly lower average of 1.1 mg/l.

The average and range of nutrient concentrations, in terms of phosphorus and nitrogen, recorded at the two monitoring stations within the zone are listed in the following table.

Parameter	Year	Carillon Dam (RM 56.8)		Oka Ferry (RM 39.0)	
		Average (mg/l)	(Min-Max) (mg/l)	Average (mg/l)	(Min-Max) (mg/l)
Total Phos- phorus (as P)	68-70	.04	.01-.10	.05	.01-.16
Soluble Phos- phorus (as P)	68-70	.01	0 -.03	.02	0-.11
Total Kjeldahl	68	.71	.08-2.0	.52	.06-1.46
	69	.63	.28-1.10	.56	.35-.95
	70	.54	.4 - .92	.59	.34-.88
NH3 (as N)	68	.12	.05-.59	.11	.01-.32
	69	.07	.01-.29	.06	.02-.12
	70	.12	.08-.19	.10	.09-.11
NO3 (as N)	68	.07	0-.15	.08	.01-.14
	69	.16	.04-.41	.13	.08-.19
	70	.15	.08-.24	.16	.13-.19

It can be seen from the table that the average concentrations for each of the parameters were practically the same at each station. Nitrite levels (not included in the table) were very low for both stations, averaging about .01 mg/l (as N).

The average and range of concentrations for the remaining chemical parameters for Zone 1 are summarized in the following table.

Parameter	Average (mg/l)	(Min-Max) (mg/l)
Total Hardness (as CaCO3)	37	24 - 54
Alkalinity (as CaCO3)	25	17 - 43
pH		6.9 - 8.1 (units)
COD	30	16 - 60
Phenol	.006	0 - .010
Total Iron (as Fe)	.45	.30 - .70
Sulphate	14	10 - 17
Lead (as Pb)	.07	0 - .19
Zinc (as Zn)	.03	0.0 - .07
Arsenic	.01	0.0 - .02

iii) Bacteriological Characteristics

Despite the excessive bacterial content of the Rigaud River (RM 50), the bacterial quality of the Ottawa River in this zone was generally found to be acceptable for recreational uses. The levels measured at Oka Ferry (RM 39.1) were slightly less than those at the Carillon Dam (RM 56.8). Data from the Oka Ferry monitoring station are presented in the following table.

	Total Coliform /100 ml	Fecal Coliform /100 ml	Entero- coccus /100 ml
1968	329 (22)	25 (8)	24 (8)
1969	240 (7)	109 (6)	48 (6)
Numbers indicated are geometric means			() number of samples

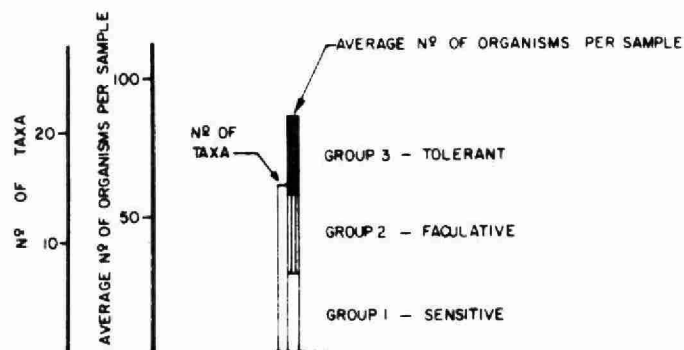
iv) Biological Characteristics

Bottom fauna communities of Zone 1 downstream to Oka were in many respects similar to those occurring in the section immediately upstream of the Carillon Dam. Generally, overall diversity was low and tolerant sludgeworm (*Limnodrilus hoffmeisteri*) were predominant at most stations indicating an extension of the effects of organic pollution from Zone 2.

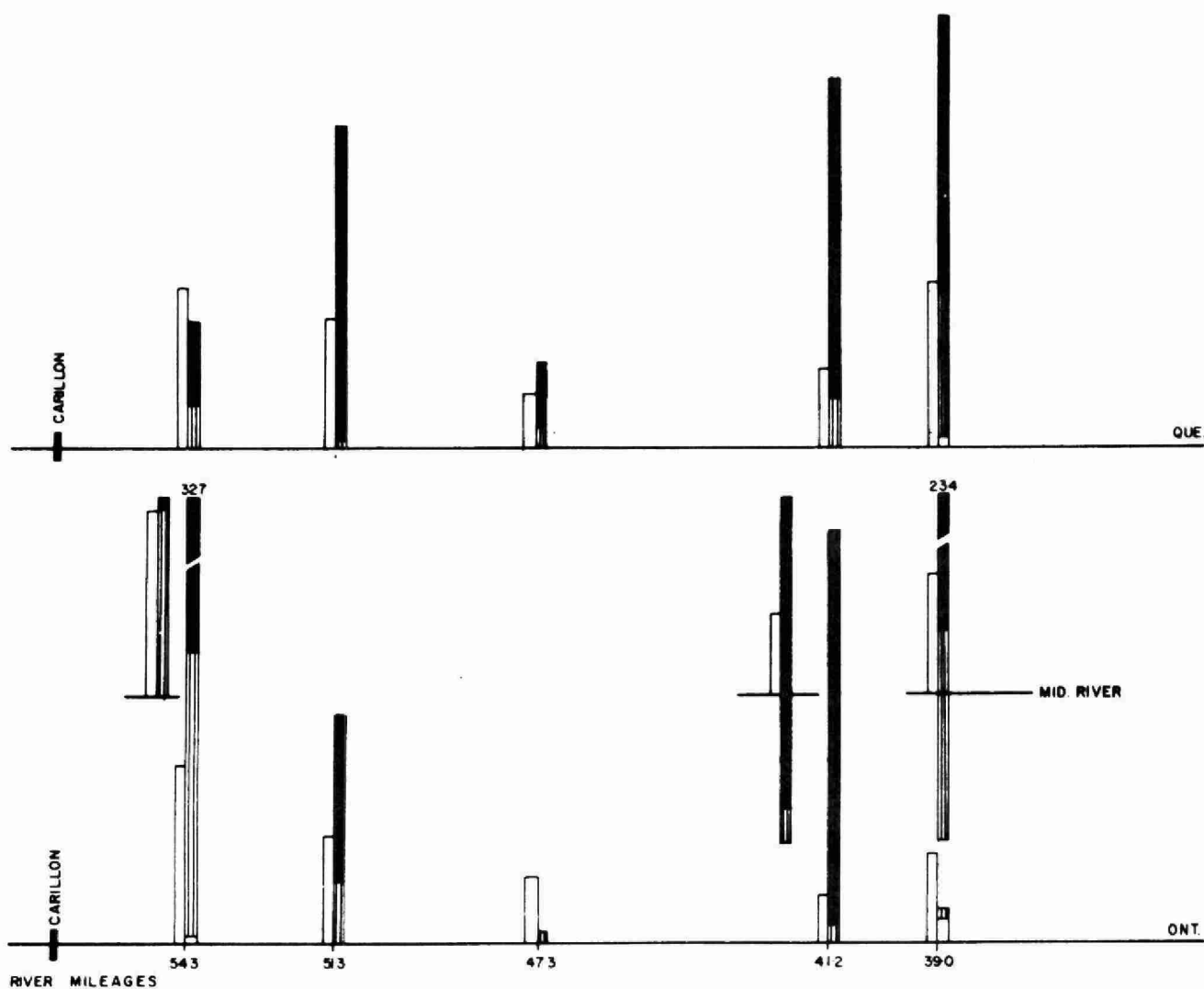
At RM 54.3, approximately 2.6 miles downstream of Carillon Dam, some improvement in bottom fauna was noted owing probably to the swifter flows and the higher reoxygenation rate in this section. At this range, the average number of taxa per station was 16.6 and semi-tolerant forms were predominant while sensitive forms were weakly represented at one station near the south shore. Downstream from this point, a gradual decrease in the variety of organisms was noted reaching a low of 8.0 taxa per station at RM 47.3, where total numbers of organisms were also restricted, and increasing to 12.6 taxa per station at RM 39.0. Recovery at this point was further indicated by the reappearance of sensitive species in shallower depths including the very sensitive mayfly, *Hexagenia*, sp., which comprised a majority of the bottom fauna at one station near the south shore. The decrease in variety of fauna and the predominance of sludgeworms (*L. hoffmeisteri*) at stations from RM 51.3 to RM 41.2 can be attributed to low levels of dissolved oxygen occurring in this section at least seasonally. As referred to below under Oxygen Resources, the low point in the oxygen sag from Zone 2 was noted at the Carillon Dam in a July study and would be expected to shift downstream during periods of lower water temperature.

FIG. F-II COMPOSITION AND ABUNDANCE
OF BOTTOM FAUNA COMMUNITIES AT
SELECTED STATIONS IN ZONE I

LEGEND



- CHANGE IN MILEAGE SCALE
- BREAK IN MILEAGE SCALE
- POWER DAM
- RESERVOIR DAM
- ↓ PULP MILL DISCHARGE
- ⋮ SANITARY DISCHARGE



v) Oxygen Resources

No significant domestic and industrial wastes are discharged directly to Zone 1. However, the dissolved oxygen resources of Zone 1 are affected throughout summer months by oxygen-demanding wastes and low dissolved oxygen levels which carry over into Zone 1 from Zone 2. The July 1968 survey of this reach revealed a minimum dissolved oxygen level of 4.3 mg/l at Carillon (RM 51.3) which recovered steadily to 5.5 mg/l about twenty miles downstream from Carillon to Oka (RM 39.1). Under critical conditions of 30,000 cfs streamflow and a 25°C water temperature, a minimum 2.0 mg/l dissolved oxygen level could be expected at Carillon.

Data provided by the Quebec Department of Tourism, Game and Fish shows that oxygen depletion during periods of ice-cover occurs throughout most of the shallow bays that form much of the surface area of Lake of Two Mountains. During the winter of 1970, minimum dissolved oxygen concentrations of 1.0 mg/l in bottom waters were recorded for most areas and in some cases values were as low as 0.0 mg/l.

APPENDIX G

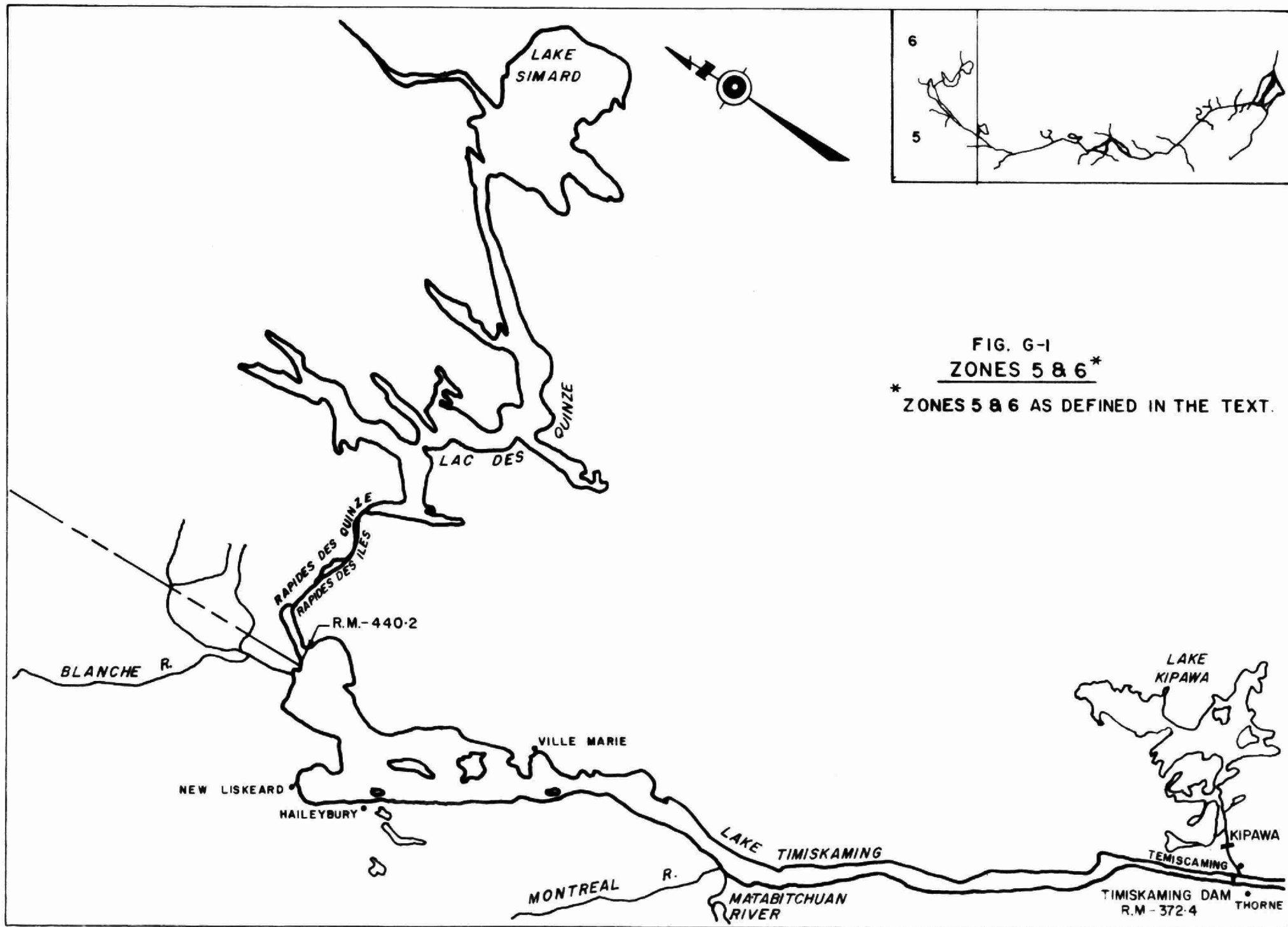
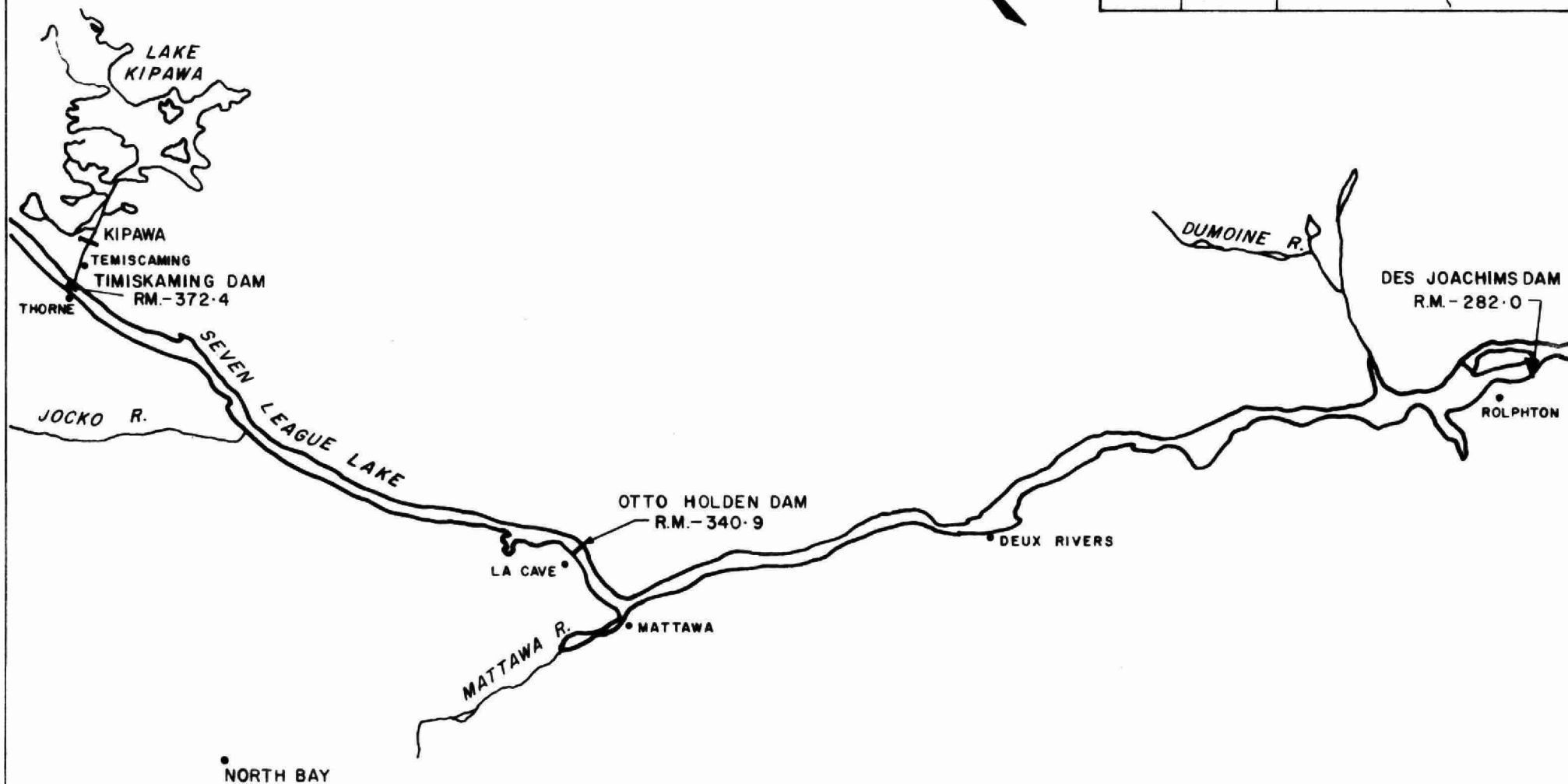
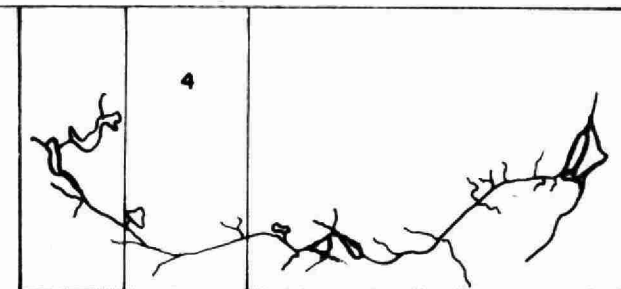
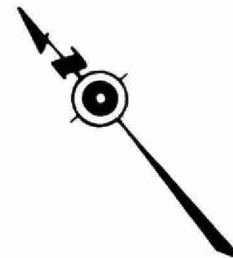


FIG. G-2
ZONE 4*

* ZONE 4 AS DEFINED IN THE TEXT.



3

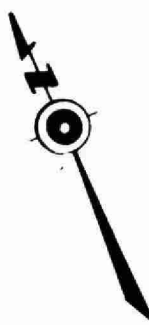
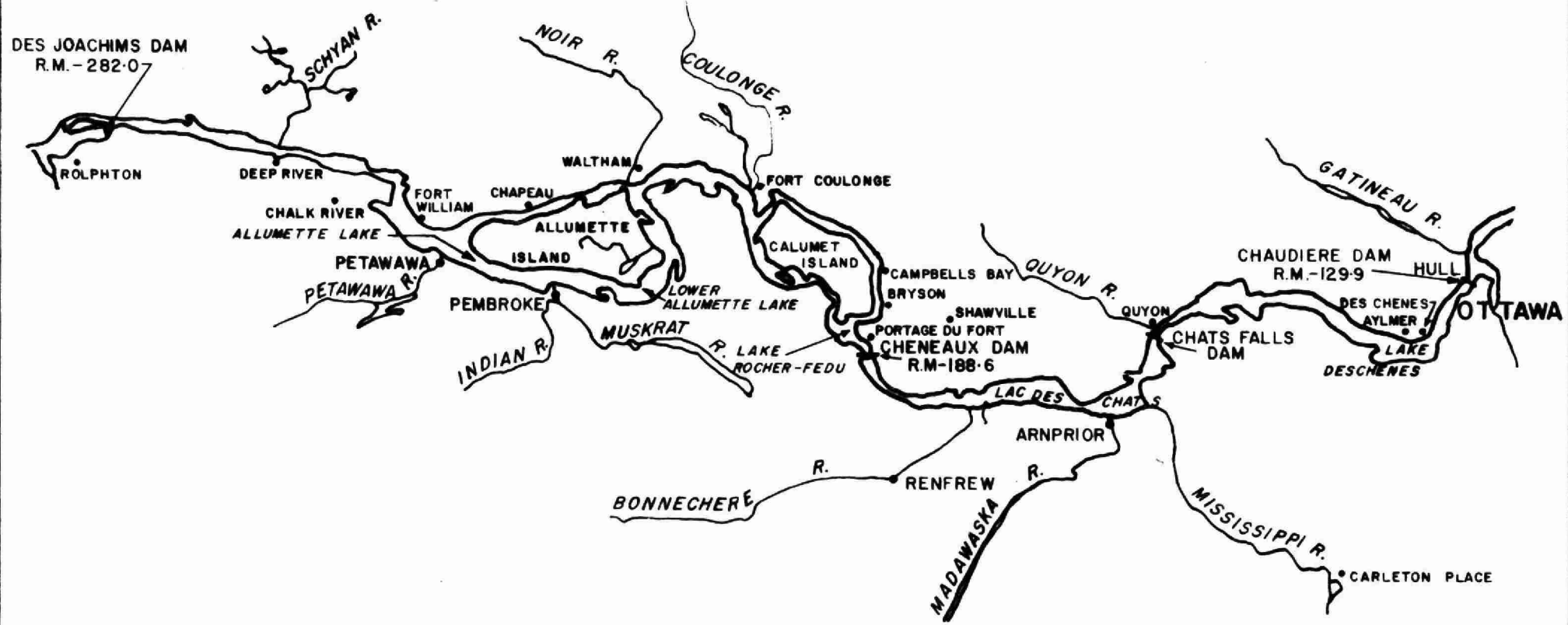


FIG. G-3
ZONE 3*

* ZONE 3 AS DEFINED IN THE TEXT.



• SMITHS
FALLS

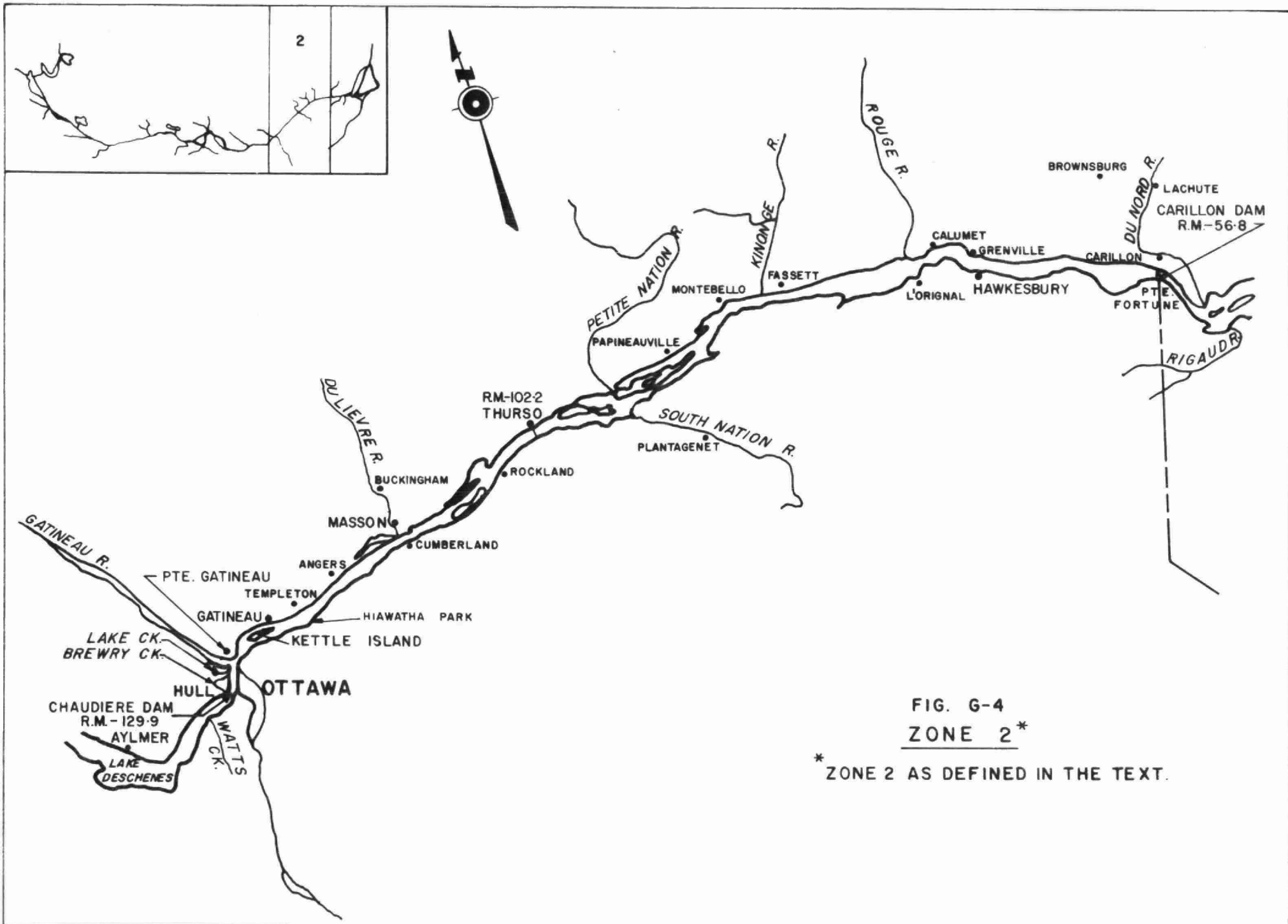


FIG. G-4
ZONE 2*

* ZONE 2 AS DEFINED IN THE TEXT.

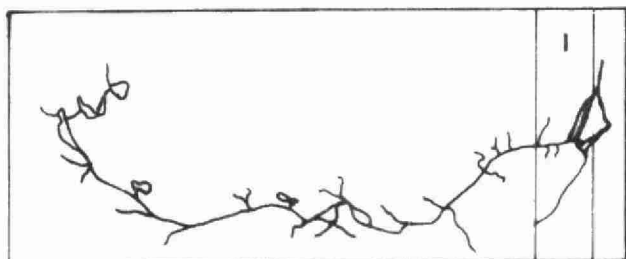


FIG. G-5
ZONE I*

* ZONE I AS DEFINED IN TEXT

